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THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by the Wilson Ornithological Club

Vol. 53 SEPTEMBER, 1941 No. 3

THE BREEDING OF THE BLACK OYSTER-CATCHER

BY J. DAN WEBSTER

THE four thousand mile coast line along which the Black Oyster-catcher (*Haematopus bachmani*) ranges includes many very different types of country but the littoral marine invertebrate fauna of the exposed shores of this area is remarkably uniform (Webster, 1941). The Sitka region, where the present study was made, is one of high precipitation and mild, even temperature. High mountains (2,500 to 4,000 feet) front the Pacific Ocean, buttressed at their feet by rocky islands and capes. From sea level to 2,500 feet luxuriant coniferous forests clothe all in green.

Five pairs of Black Oyster-catchers nested on Kayak Island in 1940, and here a large part of the observations were made. Kayak Island (Figures 1 and 2) is actually a group of islands, of which all but the most southerly, "S E Rock," are united at low tide. The location is two miles southwest of the town of Sitka, in the eastern part of

Figure 1. Kayak Island from the east.

Sitka Sound. Although the dry-land size, according to the chart, is 160 by 460 yards, these dimensions must each be increased about 60 yards to express the size in calm weather at mean low water. On all sides the shores are precipitous and rocky. The invertebrate fauna of the wide seaward shore is chiefly the "association" of *Mitella polymerus, Pisaster ochraceus,* and *Mytilus californianus*. On the landward, eastern shore the vegetation grows down nearly to the high tide line. Here the littoral fauna is of the semi-exposed type—chiefly *Acmea scutum, Balanus glandula, Strongylocentrotus franciscanus,* and *Cribina xanthogrammica.* The vegetation of the island is a dense growth of shrubbery and conifers; around the borders, and all over barren S E Rock, hardy clusters of rock buttercups (*Potentilla villosa*) and a few grasses withstand occasional salt spray, in crannies of the basalt. The pinnacle of S E Rock is only twenty-five feet above mean low water; on this barren rock three pairs of Oyster-catchers and two pairs of Pigeon Guillemots (*Cepphus columba*) had their nests. The Guillemots and Oyster-catchers, however, completely ignored each other.

The Black Oyster-catcher's nest is usually (Dawson, 1923) of one of five types:

(1) A platform or bowl of rock flakes in a cranny of the bare rock.

(2) A hollow scraped from a soil pocket in an irregularity of the rock and lined with bits of shell and rock flakes. Later in the summer grass grows up around the nest (Figure 4). This type is particularly common as a play nest, built several days before egg laying.

(3) A hollow scraped from weedy turf on a ledge several feet above spray line, and lined partially with rock flakes. One nest of this kind was found which had been dug through the shallow soil two inches to the ledge beneath, which formed a solid rock bottom on which the eggs lay.

(4) A bowl of grass or dried moss, similar to a gull's nest.

(5) A hollow scooped from unmodified beach gravel. Not found near Sitka.

The nest is built high enough to escape the flying spray of summer gales. This meant from 5 to 21 feet above mean high water—which was 7.7 feet above mean low water at Sitka—varying with the surf exposure of the site. The preferred site is the top of an isolated rock with no trees—only sparse vegetation. There is usually shelter from the prevailing winds.

The earliest and latest egg dates I recorded—a full clutch of four eggs on Kayak Island, May 9, 1940, and an egg hatching on Kayak Island on August 6 or 7, 1940—are beyond any recorded in literature, although Willett (1909) records a set taken May 14, "About half incubated." The eggs are deposited at intervals of from one to three days; incubation commences about one day after the deposition of the last egg. Of thirteen first sets examined, five consisted of two eggs

each, seven of three eggs each, and one of four eggs, an average of 2.69 eggs per clutch. Of three second sets, one consisted of one egg and two of two eggs each, an average of 1.67 eggs per clutch. Removal of eggs by Ravens (*Corvus corax*) did not stimulate the laying of additional eggs unless the entire clutch was stolen. Zerlang and Fraser (1940) report the finding of a five-egg clutch laid by a single hen. On S. E. Rock, the writer found that the territories (See figure 2) of two pairs

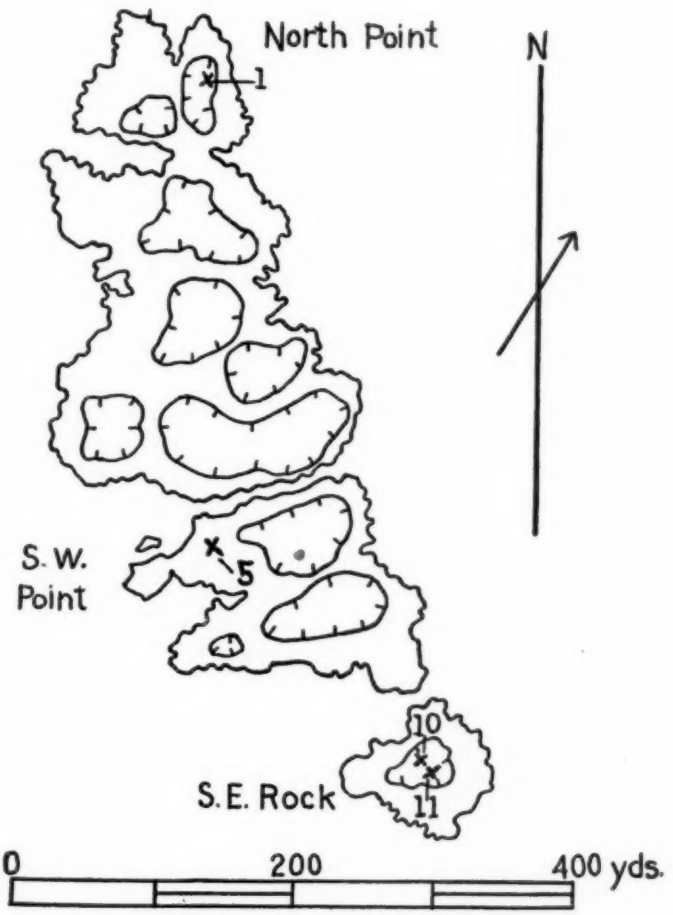

Figure 2. Kayak Island. The inner contour lines represent winter high tide line. Black Oyster-catcher nests are indicated by crosses.

of Oyster-catchers overlapped. The two hens laid in the same nest (Figure 4); one hen four eggs before May 9 and the other, evidently, two before May 17. Three of these occupying birds were shot by

poachers before observations could be made on incubation. The remaining bird (sex not known), belonging to the later-laying pair, incubated the eggs until they were destroyed on June 16.

The incubation period was observed to be 27 days in one case. Other determinations were: Not over 26 days; 26 or 27 days; 27 to 30 days. Dircksen (1932) found that the incubation period of the European Oyster-catcher (*Haematopus ostralegus*) varied from 25 to 34 days, averaging 27 days.

In winter Black Oyster-catchers are found in flocks of from two to more than fifty individuals. (The latter large flock—"over fifty birds"—was seen by George Willett at Sea Otter Harbor, Dall Island, Southeastern Alaska, in 1920. Personal communication). The Sitka Bay flock observed during 1940 ranged chiefly around the Indian River flats mussel beds and a group of rocky islets including The Twins and a headquarters rock nicknamed "Cormorant Rock." They bred over an area three miles square.

In early March there were twelve birds in the flock and several wandering pairs; definite territorial behavior was first noted in five pairs of Oyster-catchers on Kayak Island on March 22. From March 28 to April 26 there was a marked correlation between the height of the tide and the number of birds in the flocking territory. At low tide there were never more than four present; at high tide, no matter what the time of day, the number present was from six to ten. This shows a tendency in the present species like that noted in April in Holland by Huxley and Montague (1925). There the pairs of inland-breeding European Oyster-catchers gathered on the flocking grounds during the late afternoon, slept there, then went on the breeding territories during most of the day. But in the case of the Black Oyster-catcher, a marine species, the flocking period was at high tide.

By May this flock had been reduced, by the desertion of breeding birds, to two birds which were seen several times on or near Cormorant Rock throughout the summer; they usually fed on the Indian River mussel beds. They never showed territorial behavior as exhibited by nesting birds and I regarded them as non-breeding yearlings, although on May 7 they did perform a switch-back chase.

In mid June two other Oyster-catchers, evidently the pair which had deserted territory on the MacClelland Island, a mile away, joined the two on Cormorant Rock, and thus formed the carry-over from the previous winter's flock and the nucleus of the 1940–41 winter flock. These MacClelland Island birds may have been immatures—that is, Oyster-catchers in their second spring—because they established territory, built nests, but never laid eggs and abandoned their nesting place very early. Dircksen (1932) gives good proof that Oyster-catchers do not ordinarily breed until their third spring.

On July 25 the flock had increased to eight by the addition of more

unsuccessful nesters. At this time, however, many more birds, having lost their chicks, were wandering around in pairs and small flocks, sometimes reverting to their nesting territories, sometimes joining the main flock. By August 19 the flock consisted of all of the Oyster-catchers from the area, save for one very late nesting pair with their chick. This flock, consisting of twenty-two adults and two juveniles, was observed until September 5.

Piping was never observed in the flock during July or August, but it was noted during March and April. The flock's general schedule consisted of a period of resting and sleeping during high tide, crowded together on Cormorant Rock, then feeding, scattered out over a half-mile or so, on the rocks or flats on the latter part of the ebb and the

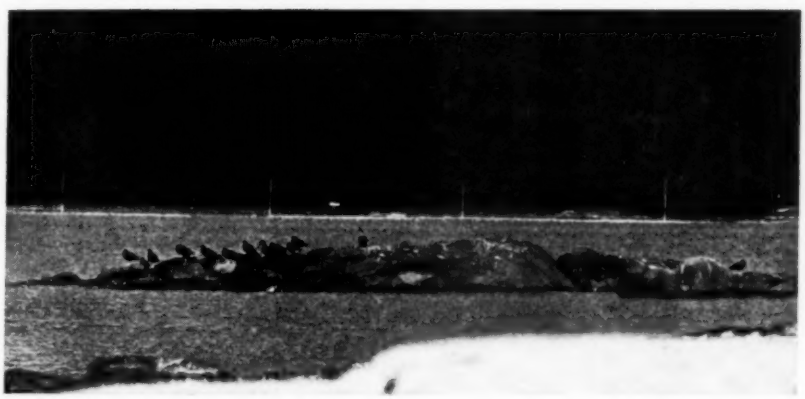

Figure 3. Flock of Black Oyster-catchers on Cormorant Rock at high tide. Note the two juveniles at the far right.

early part of the flood tide. When the Oyster-catchers had eaten their fill, they returned to Cormorant Rock to preen and sleep. An alarm when the flock was scattered soon brought them crowding together, in flight or on a single rock or point.

The actual territory claimed by each pair of Oyster-catchers varies considerably; as Buxton (1939) notes, tidally exposed rocks, which are particularly valuable for feeding, are included in the territory.

The bird not incubating sometimes flies to the distant feeding ground. In this case Indian River flats was a feeding ground for all birds within two and a half miles. However, as soon as the chicks are hatched this practice is discontinued and the bird not brooding or feeding the chicks remains within call. When the bird not incubating is not foraging, it stands on the lookout on some eminence of rock, at a distance of from five to twenty-five yards from the nest. This lookout

post is not invariably the same, but one place is used more often than any other by each pair of birds. Often this lookout post is the same spot used as a refuge when their nesting place is invaded. But the lookout position, it is noticeable, is never at a greater elevation than the nest, although such places are often available.

Behavior of Oyster-catchers when their nesting territory is invaded by man varies somewhat. Before the eggs hatch, a loud, shrill call is given continuously—*kee, kee, kee, kee*—while the birds stand on their refuge, or fly from the opposite side of the observer to the refuge and back. Often the birds attempt to lead the intruder away, running along in a semi-crouching position with the nape feathers raised and ruffled and the tail lowered (Shortt, 1939). Frequently an Oyster-catcher watches an observer from behind a rock, so that only part of the bird's head can be seen peeping over the rock. After the chicks are hatched the behavior of the parents differs in that a new call—*keek-a-keek, keek-a-keek,* or, *keek, keek, kee-akee-ooo*—is introduced, most often being given as the parents fly near the crouching chicks. In one case, however, —on the Eckholms,—a certain bird used this other call each time it was visited, even shortly after the eggs were laid. When the human invader has left and can be seen still going away at a distance of about 150 yards from the nest, the Oyster-catchers give an "All clear" piping ceremony—sometimes in unison, sometimes one alone. In the latter case the other bird, which is already approaching the nest or chicks, does not answer verbally, merely pecking the ground or bowing once. Occasionally this piping is reduced to a single note—an all clear call—which is the same as the opening note of a piping ceremony. This note, reiterated, is sometimes used by a lookout bird as it flies from one perch to another, apparently to tell its mate its location. It is lower in tone and less shrill in quality than the alarm call.

The Black Oyster-catcher is very bold in defense of its nest, intruding birds being attacked and struck until driven away. According to my observation a Raven steals eggs by watching from a nearby tree until both Oyster-catchers are away from the nest in a piping ceremony or chasing away a second Raven. The Raven then swoops suddenly down to the nest, spears an egg, and flies off with the booty. Bald Eagles are blamed for the loss of many chicks; Raven for the loss of nearly all eggs laid in certain areas. The following birds were noted being chased away from the nesting territory: Bald Eagle, Glaucous-winged Gull, Hudsonian Curlew, American Raven, and Northwestern Crow. Crows and gulls were tolerated on the feeding areas of the territory, but were driven off when they approached closer than twenty-five yards from the nest. Sparrows, guillemots, and small shore birds were ignored.

Other Oyster-catchers are sometimes driven off but more often are "bowed off" in a piping ceremony which is nearly always given on land.

In various circumstances, two or more Oyster-catchers standing near

each other point their bills vertically downward, opening them slightly, extend their necks, hunch their shoulders forward, and erect their nape feathers. A series of loud, high-pitched, sharp notes is given, *Kewik, kewik, kewik, kwik, kwik, kwik, kwik, kwirrr,* gradually becoming closer-spaced, then running into a trill which slowly dies out in intensity. During this time, the hunched-forward attitude is retained and the entire body is bobbed up and down.

Early in the spring piping ceremonies are frequent at the boundaries of territories, with four birds taking part. The most common piping ceremony observed was of three birds, when one extraneous bird entered the territory of a pair. Often this occurred while the observer was rowing away, and the previously alarmed pair, which had called a third bird over to join in hurling maledictions at the human intruder, edged the foreign Oyster-catcher away in a more or less extended bowing trio that replaced the usual "All clear" duet or solo. Soon the third bird flew off to his own territory. Following are the field notes of a case of this kind observed on Kayak Island on June 10, from a blind ten feet from nest 1 (See map):

E and F were the birds holding the nest near the blind. If Buxton [1939] was right in believing that only the hen clucks, then E was the cock, F the hen. A was the non-incubating bird from nest 5, 300 yards away.

3:10 P.M.—David* left the blind. At least two of the three eggs were pipped and the chicks were peeping. F was fifteen yards northwest of the nest with A; E was twenty-five yards southeast of the nest.

3:17—E flew to join A and F when David disappeared 250 yards to the south. F began piping, facing A, as E landed parallel to her and a few inches away. E immediately joined F in piping, the two bowing alternately, and walking, slowly, stiffly west, away from the nest. A postured and bowed, did not pipe, walked out of sight behind a boulder.

3:22—A flew off west. E and F flew to the lookout, twenty-five yards southeast of the nest.

3:24—F flew to a point below the nest, and fifteen yards east.

3:26—F rapidly flew and walked to the nest, crouched; fluffed feathers and wiggled for quite a while; the peeping of the chicks ceased.

3:35—E moved up to a point fifteen yards east of the nest, stared at the blind.

4:00—E left to join other oyster-catchers which could be heard giving the alarm call on the other end of the island.

4:07—E returned, landed ten yards north of the nest.

4:15—I made a loud noise in the blind, frightening F from the nest. As F landed beside him, E began bowing and the two gave a piping ceremony ten yards north of the nest.

Sometimes piping is given in flight by a group of four or more birds; in such case the bill is pointed straight downward, but the shoulder-hunching and bowing are absent. "When the piping is given in flight a peculiar form of flight is used; the flapping is swift but the forward progress is slow" (Buxton, 1939). According to Dircksen

* My brother David acted as assistant, helping me in many ways. Thanks are also extended to Dr. Arthur A. Allen and to countless other friends and councilors at Sitka and at Ithaca.

(1932), these piping flights do not begin until ten days before the eggs are laid, and disappear by the time the first eggs hatch. I observed this "flight piping" ("Flugbalz" of Dircksen, 1932) several times on Kayak Island. The piping birds circled the island, the lookout bird of each pair joining the group as it passed and flying with it. Usually the incubating bird pecked the ground, a sign of excitement; sometimes it left, to pipe with the others. Probably this performance is an expression of social excitement. One particularly noteworthy fact is that the larger the piping group, the longer the excitement lasts and the more intense the excitement appears (See Huxley and Montague, 1925).

Performances in which only two birds take part are common. Usually the ceremony begins when one bird, which has been at a distance, flies to its mate and lands beside it. The stationary bird begins piping as it watches its mate land, then both bow and pipe together. The ceremony is self-exhausting and afterward the birds resume their normal activities (i.e., preening, sleeping, feeding, or incubating).

Huxley and Montague (1925) observed a type of flight which they called "Butterfly flight"; Dircksen (1932) also observed this in May. It consisted of a lazy floating flight, with slow wingbeats of large amplitude. Never was this behavior seen at Sitka, nor was the "Flutter flight" of Dircksen observed. This latter involved wing movement of very small amplitude.

During May especially, Black Oyster-catchers frequently indulge in the "Switchback chase" described first by Huxley and Montague (1925). Two birds fly low over the water, one in close pursuit of the other. Now and again the pursued bird, followed by the other, rises into the air, skidding on to one side; then they side-slip diagonally down and continue their pursuit. Sometimes a mated pair indulges in this flight, although this is not common. On one occasion, July 12 on Mahknati Island, the female (proved by subsequent collection) of the invaded territory pursued an invader of an unknown sex (whose mate was also invading the territory) for a long time in a switchback chase. Finally, after a circular and figure-eight course of at least two miles had been traversed, the pursued bird landed on a rock one quarter mile distant. The pursuer landed with him, but very soon returned to her breeding territory. Soon after the other invading bird rejoined its mate. Incidentally, the male of the territory was dead, having been shot just before this episode.

Late in the summer (on August 6) a pair which was flying on a straight route between islands was noted to side-slip occasionally, as though partially reverting to the switchback chase of a few weeks before.

Coition in oyster-catchers is peculiar in involving no special preliminary or subsequent ceremony. I observed the act only once—on March 22, 1940. The cock flew onto the hen's back from a distance,

half extended his wings for balance, and finally hopped off. The hen turned her head to look at the cock on her back. After the performance, neither of them having uttered an audible sound, both began preening and dozing as though nothing had occurred.

"As with so many birds, the oyster-catcher has the habit, in certain moments of excitement, of pecking at the ground, and at small straws on the ground in a curious, aimless and excited manner" (Huxley and Montague, 1925). On the nest this is particularly noticeable when the brooding bird is distrustful of the observer's camera or blind; it nibbles and pecks at straws and blades of grass. Huxley and Montague noted pecking at the ground, "Occasionally, after the close of a piping performance; occasionally, after coition; occasionally, when males or pairs on adjoining territories were close to each other in a state of nervous tension. Nervous tension is also characterized by bobbing." Bobbing, or bowing, is also a sympathetic action when a bird hears or sees other individuals at some distance in a true piping performance.

Despite a recent statement to the contrary (Lack, 1940), there is good evidence that oyster-catchers remain mated for life: (1) The writer has always observed Black Oyster-catchers segregated into pairs, even when flocking. This observation seems to check with those of other ornithologists, for example, Michael (1938). (2) Dircksen (1932) once saw a complicated offering ceremony, and once a fight between two cocks. The simple absence of other such observations indicates that the mating ceremony is so infrequent as to occur but once in the lifetime of each oyster-catcher. (3) Dircksen recorded a case in Germany in which a pair of banded oyster-catchers nested for seven successive years in the same spot.

During the ten days to two weeks preceding egg laying, Black Oyster-catchers usually build several "play nests," which are in most cases inferior in construction to the nest finally used. Which sex does the actual work of carrying the rock flakes, often from a distance as great as fifty yards, is not known. On the single occasion when actual nest building was observed, the hen was arranging the nest just after deposition of the first egg, and the cock was feeding. At any rate, nearly always construction of the final nest is not begun until a very few hours before deposition of the first egg. The hen squats on the nest but a short time in deposition—not long enough to warm any other egg which may be present.

The nest lining (Buxton, 1939 and Dircksen, 1932) is added to in two ways. The brooding bird often absent-mindedly nibbles and arranges with its bill, and once in a while brings a decoration such as a rock or shell from a distance.

At the first alarm call from the lookout bird, the incubating bird rises, then flies on a circular course to join its mate. (See Dawson, 1923). Alarm calls from Oyster-catchers 300 or more yards away cause

the incubating bird to merely cock its head in interest, as it does when Crows caw angrily nearby. Incubation is not left to the heat of the sun, as I learned by long observation on one of the hottest days of the year (80°F.) at Sitka. The birds covered the eggs closely all day.

Observations of nest 5, Kayak Island, on May 30 from a point seventy yards north of the nest show the schedule followed by the pair. In general, the lookout bird put its bill under its scapulars for a two or three minute period, looked about for five minutes or so, then put its bill under its scapulars again. Such observations are omitted below.

12:55—Both birds on S W Point, fifteen yards south of the nest as I walked to the blind; both gave a few alarm calls.
12:59—Both alert; A preened.
1:05—B gave a single all clear call.
1:06—B flew to a point of rock eight yards south of the nest.
1:08—B flew to the nest, squatted.
1:32—A looked up, walked a few feet nearer nest, to the regular lookout spot.
1:34—Two oyster-catchers piped on S E Rock; both A and B cocked their heads, listened; A pecked the ground.
1:55—A looked up, shook tail, preened, stood alert.
2:00—A flew down to the rock just north of S W point, which was just well clear of the receding tide, began feeding.
2:05—B looked up from the nest; A looked up every half minute or so while feeding.
2:16—A flew up, circled my blind twice, flew out of sight through the crevice to the east. B looked up from the nest.
2:20-2:22—Piping on S E Rock; presumably A had invaded territory.
2:23—A returned to S W Point from the south.
2:24—Eighteen minutes before low tide. B flew from the nest, flew 100 yards straight out to sea (southwest), turned, flew at an altitude of fifty feet back to S. W. Point, landed on the rock pinnacle six yards west of A; bowed and piped; A bowed but did not pipe.
2:26—A flew to twelve yards south of the nest.
2:27—A flew to the nest; B flew to Crevice Rock, stood alert.
2:29—A squatted; B flew to seventy-five yards north of the nest, landed near the water's edge, crouched on rock.
2:42—Tide at low point.
2:49—B flew north, soon returned with E (from nest 1); the two circled my blind, then flew back north, E leading.
2:51—B returned alone.
2:52—B resumed feeding.
2:55—B flew to the lookout spot on S W Point, walked around, shook its head.
3:10—B preened at length.
3:15—B walked to far side of S W Point, out of sight.
3:37—Piping on S E Rock—A looked up from the nest, pecked the ground.
3:41—B flew up, calling several times, circled the nest, landed eight yards south of the nest.
3:44—B put its bill under its scapulars.
3:59—I left.

On June 11 the changing-over of this pair was again observed. This time the incubating bird left the nest just four minutes after the

tide had turned and flew directly to a point near its mate on S W Point. Both bowed and piped; then, after two minutes of inactivity, the other bird began moving toward the nest. These cases, together with stomach analyses of specimens taken and the fact that many hours of observation at high and middle tides failed to record a change of incubating bird, have led to the formulation of the following theory: A pair of Black Oyster-catchers change places on the nest very near the time of

Figure 4. Nest 10, Kayak Island, with six eggs laid by two hens.

each low tide; that is, every twelve hours. Possibly this routine is changed if the birds are disturbed.

The parent Black Oyster-catchers are careful and anxious. During the first day or day and a half the chicks are brooded almost continuously; then for one week commonly; during the second and third weeks only when it is raining; after that not at all. The offer of cover includes a clucking note, similar to that given by the incubating bird as it squats down on the eggs. Whether both sexes cluck, however, is not certain. When there is danger near, the old birds give their special cry and the chicks crouch until the all clear signal is given.

Routine is the same as during incubation. One parent stands guard and feeds himself while the other feeds the chicks (and, probably, eats a little); then they change off at the turn of the tide and the second parent stands watch or eats while the first feeds the chicks. During high tide, one bird stands near the chicks or covers them and the other stands at some distance, usually at a greater elevation than its family.

Behavior of young European Oyster-catchers was analyzed in detail by Dewar (1920) and his work should be read for a full understanding of the progress of the young birds.

Figure 5. Black Oyster-catcher incubating.

By the third day the chick can run well and swim expertly; it can scramble over large obstacles, and fall from a veritable precipice without injury. The wings are frequently exercised until actual flight begins in the fifth week.

In a chick just out of the shell, with down still wet, crouching is readily induced but does not last long, and the chick struggles when seized. By the fourth day the chicks spread out at the parent alarm, and crouching persists even on handling. Toward the end of the second week crouching is maintained even in an inverted position, and may last for an hour and a half. The chick raises its head at this age when

the parents cease calling for a few seconds, if the danger is not visible, and then lays its bill on the rock again as the old bird flies overhead, calling loudly. In the fourth week crouching is often supplemented by hiding in vegetation, and in the seventh week tends to be replaced by flight.

Preening begins about the fifth day of the chick's life, and about the same time the bill, when soiled, is wiped on the plumage. In the fifth week the chick commences to rest on one foot and sleep with the bill under the scapulars.

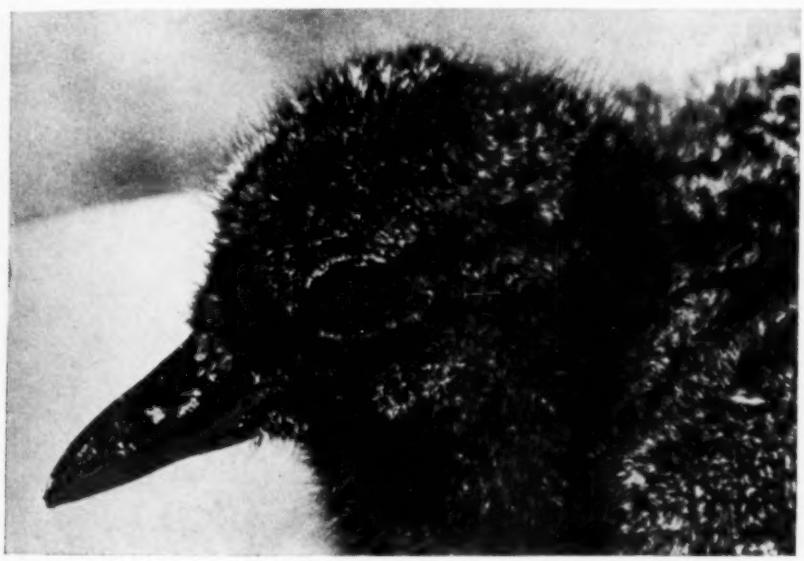

Figure 6. Black Oyster-catcher one week old. Note the egg tooth.

Feeding begins on the second day, when food is brought by the parents to a point near the nest and offered in small fragments which are pointed out. The parents bring limpets and chitons and those mussels which are torn entire from the rock to the chick and clean them from the shell there. Barnacles, of course, are brought in the flesh. Disposition of mussels when the chick is not near the foraging place and the shells cannot be torn from their anchorage (See Webster, 1941.) is not certain. Probably most mussels opened by the foraging bird are eaten immediately rather than carried to the chick. It may be, however, that only mussels with the ventral border up are taken when the chick is not following, and those few can be opened, torn loose and cleaned near the chick. The chick does not follow the foraging parent until the

third to fifth week, depending on the difficulty of descent to the feeding areas. By the fifth day the chick picks insects off vegetation or rocks. At least by the thirtieth day it can neatly remove limpets and mussels from their shells—a complicated process; but chitons are too tough for it until the sixth week. In the fifth week the chick probes tentatively at the mussels, with little success; not until it is three or four months of age can it open mussels and barnacles rapidly and remove chitons and limpets from the rocks. Williams (1927) records adults obtaining food for young chicks as late as November 3.

Excitement or alarm are indicated from the sixth day onward by bobbing and tapping the ground. From the thirteenth day onward satisfaction is shown by sidewise waggling of the tail after feeding.

Observations of fledged chicks were few, but two banded young which had often been studied before fledging, were found again on August 10, at the age of 57 days, two miles from the nest. Dircksen (1932) and Buxton (1939) record a shift of territory as chicks move before learning to fly. The calls of these juveniles were at this time, as they continued for another month, more shrill than those of the adults, but they were given similarly—that is, a steady flow of alarm notes, which were run together in more rapid succession just as the bird took wing. The parents were much alarmed, but did not hover close to the young, one of which let the observer row within ten yards before flying. The juveniles' path of flight followed that of the parents. These two juveniles joined the flock at high tide as early as their sixty-seventh day, but held somewhat aloof (See figure 3). At low tide, of course, they followed their parents to be fed.

One juvenile was kept in captivity from her thirty-fifth day until her sixtieth. When mussels were opened several feet from her cage, she gave two or three squeaky, expectant calls. It was found that 120 large mussels per day were necessary for continued growth.

During spring and early summer of 1940, a census was made of the Black Oyster-catchers in eastern Sitka Sound, that is between Point of Shoals and Whitestone Narrows on the north and Kita Island on the south. There were found to be 26 non-breeding birds, presumably sub-adults, and 76 breeding birds defending territory. This is on a linear strip of about twenty-five miles. In early September a careful survey of ten miles of this strip, which had contained 62 Oyster-catchers, showed that they had for the most part gathered into flocks. One flock of 24 birds, including two juveniles, ranged around Cormorant Rock, The Twins, and Indian River flats. A second flock of 24 birds, including three juveniles, roamed the rocks and islets near Povorotni Point, seven miles south of Sitka. Further southwest, 10 birds, of which four were juveniles, occupied the rocks just northeast of Kita Island where they had bred. And on Kayak Island, one pair still had an

unfledged chick. The total was 51 birds in adult plumage and 10 juveniles. Four of the eleven missing birds had been collected by the writer; at least four had been shot by poachers.

With data on 84 pairs of nesting European Oyster-catchers on the island of Norderoog, in the North Sea, Dircksen (1932) calculated that the life expectancy of a fledged young is eight and three-fourths years. He trapped one breeding bird which had been banded as a juvenile on the island nineteen years before.

Figures obtained by the writer at Sitka give an average life span of about seven years by the same method, as follows:

Twenty-four breeding pairs raised ten young in one year.

A pair of adult birds would therefore, raise two young in five years.

Five plus two and three-fourths (the age at which the young first breed) equals seven and three-fourths years, average life span of fledged young. If two of the three juveniles collected had instead been fledged—a probable figure—then this life span would be six and three-fourths years.

Of the total of 133 museum specimens examined of Black Oyster-catchers more than four weeks of age, there were 68 females, 64 males, and one not sexed. This suggests a sex ratio of 1.06:1.00.

Summary

The incubation period of the Black Oyster-catcher is usually 27 days. During the winter Oyster-catchers congregate in flocks which are scattered at low tide for feeding and crowded together at high tide for resting and sleeping. The breeding territory of a pair of Oyster-catchers contains important feeding places; it is defended from April to August. Both male and female incubate, changing places each low tide. The non-incubating bird, when not feeding, stands guard near the nest. The piping ceremony variously expresses sexual excitement, territorial jealousy, or social excitement. Pecking at the ground and bowing indicate nervous emotion. Parents caring for chicks exchange places each low tide; one cares for the chicks for twelve hours, then feeds and stands guard for twelve hours.

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NEWARK, CALIFORNIA

THE BELLIGERENCY OF THE KINGBIRD [1]

BY DAVID E. DAVIS

ANALYSIS of the aggressive, belligerent behavior of the Eastern Kingbird (*Tyrannus tyrannus*) should assist in the understanding of the psychology of territorialism. Territory in bird life as first conceived pertained solely to intraspecific fighting. The careful study of other species has clarified and in certain respects altered the concept. It is now becoming clear that, while there is a general pattern of behavior, each species manifests territorialism in a manner peculiar to that species. This paper describes and analyzes the manner in which the Kingbird shows territorialism and discusses this behavior in relation to the territorialism of other species.

The Kingbird is notorious for its habit of driving away other species and of pursuing predators. This behavior is interspecific; the behavior usually considered in papers on territory is intraspecific. A comparative study of many species indicates that fighting has at least two important motivations (Davis, 1940a). The defense of the sex-partner is one cause and the defense of the piece of land (nest site) is another. A third type of fighting which comes into prominence in the Kingbirds (Tyranninae) is the pursuit of predators. Other types of fighting are present in certain other species of birds. This classification of motivations holds for fish and lizards as well as for birds.

Belligerency is a widespread characteristic of this group of flycatchers. My observations in Cuba on *Tyrannus dominicensis* and *Tolmarchus caudifasciatus*, in British Guiana on *Pitangus sulphuratus*, and in Argentina on *Tyrannus melancholicus* indicate that the fighting of the Eastern Kingbird is typical of the whole group. An analysis of the behavior of *Tyrannus tyrannus* is probably valid for the whole subfamily (Tyranninae) and perhaps even other subfamilies.

This study was made by the usual field observational technics. It was not found necessary to use colored bands for individual birds although certain observations, incidental to the major problem investigated, could have been made had colored bands been used. No blind was used since the birds were sufficiently tame for observation. The sexes may be easily distinguished by the behavior as described below or by the presence, only in the female, of the brood patch. This area is noticeable as a dark line down the middle of the abdomen where the contour feathers of each side fail to meet. Sometimes in a strong wind the feathers are blown aside so that the patch is plainly visible. The red spot in the crest of the male is reputed to be larger than that

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of the female. But this difference, if it exists, is of no value for the determination of sex in the field.

The observations were made on the Edmund Niles Huyck Preserve at Rensselaerville, New York, during the summer of 1940. The preserve is a tract of land in the Helderberg Mountains just north of the Catskills. The altitude is about 1,500 feet, resulting in slightly cooler weather than in the nearby lowlands. Most of the land is, or has been, under cultivation. There are several small streams and two ponds, providing ideal habitat for the Kingbirds.

A perusal of the literature concerning the species produces a mass of incidental notes, little of which is pertinent to the problem under consideration.

Belligerency

The fighting of the Kingbird may be divided into three types. (1) The fighting against the members of the same species (intraspecific) is the most fierce and conspicuous. (2) The battles with other species (interspecific) occur frequently but lack the violence of intraspecific fighting. (3) The fights with predators show distinct behavioristic differences from the types above mentioned.

The fighting against members of the same species (intraspecific) occurs in nature only when there is an intrusion onto the territory by a strange bird. During the beginning of the breeding season such encounters are frequent. The method of acquiring territory in this species is as follows. Single birds fly about searching for mates. After these single birds find mates, then the pairs wander around for several days looking for a suitable territory and nest site. This acquisition of the territory after pairing differs from the method used by many other species and permits frequent encounters between birds which have a territory and those which are still wandering about. When a single bird enters the territory of a pair it is driven out at once. The pair which has already acquired a territory defends the area in violent fights. A most important point is that both sexes cooperate to drive out the intruder. The female fights as vigorously as the male. Another important point is that the territory defended decreases in size as the season progresses. Towards the middle of the incubation period the territory is relatively small and the encounters with strangers are infrequent, in part due to the small territory and in part due to the fact that there are few birds wandering around looking for mates. At the end of the breeding season, more single birds are traveling about and more skirmishes occur.

The fighting consists of air battles, conducted with a great chattering and display. A note *b-zee* is used in addition to the *tik* note. A great tumbling display occurs when the intruder is some distance away. This display has many of the characteristics of the song-display of certain

passerine birds. The male certainly uses this display and, although at no time was the female certainly identified performing the display, it is possible that at times she also displays. The bird flies high in the air chattering with wings quivering and then, after tumbling, climbs high again and repeats the tumble several times. This tumbling performance was on several occasions performed simultaneously by birds of adjoining territories. On one occasion in the evening, the male sat in a tall tree, called and then performed just before going to his favorite place to sleep. No other male was known to be present at that time. This tumbling display, as used in fighting, serves the same ends as the territory song in many passerine birds.

In order to examine further the behavior involved in the defense of the territory against the strangers, experiments were performed with stuffed dummies. These dummies were museum skins arranged to resemble more or less a live bird and attached to a stick. Three species, *Tyrannus tyrannus, T. dominicensis,* and *T. verticalis* were used. The dummy was placed near the nest and in one case put directly on the nest. As was the case with live birds, both the male and the female fought against the dummy. The reaction of individual birds against the same dummy varies greatly but usually consists of a startled hovering at first, followed by direct attacks. If the dummy remains for an hour or more the birds get accustomed to it and resume the normal behavior. There was no observable difference in reactions towards the three species of dummies used. The following field notes describe some of the encounters in detail. On June 23, I put the dummy about a foot from the nest of the Pond pair. "The female went to the nest, hovered above the dummy. She then touched it with the bill, sat beside it and went on the nest, twittering. The male came in and sat near (6 inches) and looked around. He then went back on the wire. At 9:18 the female went off the nest and the male came and hovered over the dummy. She came back at 9:24 and sat on a twig before flying to the dummy. She called, peered at the dummy and then went onto the nest twittering." This incident is much milder than the following with the Dam pair of birds. The dummy was put near the nest. "At 7:15 A.M. the male (as proved by later identification) sat on a twig, and hovered over the dummy, snapping the bill and using the territorial *b-zee* call." Once it chased away a Grasshopper Sparrow (*Ammodramus savannarum*). The male went away for a short time but soon came back. At 8:00 the female carried in nest material and hovered over the decoy, this being the first time she had seen it. "She attacked it, snapping her bill and knocked it over. The male hovered over it and snapped his bill. At 8:20 both birds left." It should be noted that while the female actually hit the dummy, the male did not do so, a sex difference which occurred with other pairs. These observations are typical of many experiments and show that while the male does

at times actually dive at the dummy, the female is far more aggressive. The behavior of the two sexes in reference to the intruder differs in other small details of perching and use of the notes. These details are indescribable, but after experience may be used to distinguish the sexes of the birds.

Some observations on the defense of the territory when an enemy (human) is present are of interest. On June 28, while I was putting up the dummy, the female dove at it and hit it violently. This indicates that she was more concerned about the presence of a Kingbird stranger than of a human predator. At other times this particular bird was greatly concerned over my presence and attacked me violently. On another occasion at another nest when I approached, the adults were greatly concerned because the young had just left the nest. A bird from a nearby territory came near to investigate the situation and sat calling in a tree about 40 feet away. In this case the parents ignored the intruder although it is certain that under normal circumstances it would have been attacked and driven out in a moment. In both cases the birds attacked the object which was closest to the object defended, that is, nest or young. These observations on intraspecific fighting show clearly that the Kingbirds defend a territory against other members of the species; this fighting will be analyzed in the discussion below after the data concerning the interspecific fighting are mentioned.

The term "interspecific fighting" refers to battles between Kingbirds and all other species except obvious predators such as Crows and hawks. This fighting occurs only in the immediate vicinity of the nest. With one exception no interspecific fighting was observed more than 30 feet from the nest. In this one case a male attacked a young Barn Swallow (*Hirundo erythrogaster*) about 50 yards from the nest without any obvious cause. Witmer Stone (1937:671) has remarked that Kingbirds are "valiant defenders of their nest" and attack "nearly every bird that passes near." The important characteristic of this interspecific fighting is that only the male fights. On no occasion was the female seen to fight. The following observations emphasize this fact. "June 18. When a warbler came into the nest tree the incubating female paid no attention to it. A Song Sparrow (*Melospiza melodia*) sang in the tree for 10 minutes but the female paid no attention to it. The male was some distance away. A Magnolia Warbler (*Dendroica magnolia*) came into the tree, just as the male came onto the wire. It fiercely drove the warbler out at once." "June 25. At one time the female sat within two yards of a Song Sparrow which the male drove away when he came." Olive Thorne Miller (1892) records one case in which the female joined the male in attacking an intruder. But the behavior of the female is not described in detail; possibly the female flew off the nest at the same time the male attacked the intruder. Another characteristic of interspecific fighting is that the

male does not raise the crest when attacking another species. When fighting with another Kingbird both male and female erect the crest.

In order to incite the wrath of the male Kingbird, the intruder must satisfy certain conditions. As a rule a bird merely passing over the nest tree is not disturbed; swallows swooped by unharmed, and on one occasion a Flicker (*Colaptes auratus*) flew over unmolested. Another condition is that the bird must be moving into, about, or from the nest tree. The male seldom attacks a perched bird, although sometimes when the bird is singing in the nest tree the male drives it out. A last condition is that the bird must be above the ground to incite molestation. Robins (*Turdus migratorius*) and Catbirds (*Dumetella carolinensis*) feeding on the ground under the nest tree are left alone. This horizontal stratification of the defense area is of great interest. The male does not come from a distance to drive out intruders even though the bird satisfies these conditions. These three conditions seem to be necessary to stimulate the male to attack. On some occasions, especially after a wandering Kingbird has been driven away, the male attacks birds at a greater distance from the nest site. The battle with an invader seems to excite the male. A further point of interest is that in the evening shortly after sunset the male loses the desire to defend the territory, even against strangers and will permit any bird to come into the nest tree.

The interspecific fighting wanes very noticeably during the progress of the breeding period. In order to give some quantitative idea of the diminution of the fighting impulse the following data indicate the number of times an intruding bird was driven out. These data are crude observations; in many cases it is not certain that all the conditions were fulfilled; furthermore not all the encounters but only those witnessed are enumerated. Nevertheless these rough data show a definite trend. During the nest building period the intruding bird (various species) was driven away 8 out of 17 possible times; during incubation the intruder was attacked 3 out of 10 times. In the feeding period the invader was driven away only twice out of 16 times. The diminution of the attacks is more noticeable to the observer than these quantitative data can indicate. Gilbert H. Trafton (1908) observed a nest in a gutter of a house and states that "this pair showed none of the reputed pugnacity of the Kingbird toward other birds." However, his observations refer primarily to the feeding period and he does not state how near the other species came to the nest.

The Kingbird is usually the victor in the skirmishes with other species but on some occasions the intruder emerged victorious. In two encounters Robins won and in one other battle a Baltimore Oriole (*Icterus galbula*) repelled the attacks. Both species resisted the attacks by using the bill and fluttering the wings.

Many other species drive intruders away from the nest area. The

behavior of Hummingbirds and Song Sparrows (Nice, 1937) are examples. The latter species drives away most other species, unless they are too large or indifferent. House Sparrows (*Passer domesticus*) and Goldfinches (*Spinus tristis*) ignore the threats of the Song Sparrows. Field Sparrows (*Spizella pusilla*), although attacked, succeeded in nesting among the Song Sparrows. Although Nice does not state under what circumstances an intruder is driven off, apparently the Song Sparrow differs from the Kingbird. The latter drives off all birds which satisfy certain characteristics of behavior. The former does not attempt, or at least is unable, to drive certain species away.

Interspecific fighting has different behavior characteristics from that of defense against a predator. Both sexes attack predators and, it is most important to note, go far away from the nest and outside the territory. The male is the more aggressive and goes the farther away from the nest site. Crows and Red-tailed Hawks (*Buteo borealis*) are pursued and attacked from above. It is not uncommon to see the little bird clinging to the back of the larger and pecking out feathers. A Cooper's Hawk (*Accipiter cooperi*) is, however, treated with the respect due his superior ability. The Kingbirds fly up to the hawk but never get within more than a couple of yards and hesitatingly follow it till the danger is past. Cats are pursued with the usual *tik* note and sometimes attacked from above. When a person approaches very near to the nest or handles the contents, the birds may dive at him and frequently click the bill.

Life History

During the investigation of the belligerency of the Kingbird many observations were obtained on the habits of the species. During the summer seven nests were followed in detail, two of which were observed from the very start of courtship to the dispersion of the young. It is not the purpose of this section to record every observation of the birds but only those which seem significant or add information about the relation of the behavior of Kingbirds to the habits of other species.

The pairing of this species differs from that of many other birds. Single birds wander around until a mate is found. Under these circumstances it is impossible to see the exact mechanism of pairing for the investigator is seldom so fortunate as to be on the spot when pairing takes place. The unpaired birds of both sexes give a call which is different from that of a mated bird. This call is the *b-zee* note but does not descend in pitch and is slightly shorter in duration. It is very difficult to distinguish the two calls but it can be done with practice. After pairing has occurred, the birds settle down in a suitable place. Frequently the pair searches for a location, going sometimes a great distance.

After pairing the birds select a territory around the nest site. The

observations on the Dam pair showed without doubt that the nest location is selected first and then the territory acquired around it. This pair built two nests and each time obtained the territory around the nest site. Other observations of the Myosotis pair show that the nest site is the first object acquired. This pair built three nests in different locations and each time acquired the territory around the nest site. Several days are required for the pair to outline the territory around the nest site and during this period the birds wander over a large area. After the boundaries are defined the birds restrict their activities to the territory.

The nest is located typically out near the end of a limb in a small shrubby tree. All the nests under observation were located in apple trees. This tree seems to provide the ideal site for the birds; the tree is bushy out to the end of the limbs and the small branches provide adequate support for the nest. One nest was started in an oak tree but was soon abandoned. The pair then built in an apple tree. The birds have a decided preference for water, building near a stream or pond in nearly all cases. A. W. Schorger (1920) observed this characteristic in Wisconsin and quoted R. W. Chaney's similar notes from Michigan.

The female selects the site for the nest, hopping about a tree and trying various forks by revolving about in them. The male is an interested follower but has no choice in the final selection. The construction of the nest is also done entirely by the female. She picks the grasses, twigs, and rootlets from the ground. In no case was the male seen to carry material or assist in any way in the building. The male, however, is a zealous guardian of the nest site while the female works and greets her every time she returns with material. He often accompanies her for a short distance out from the nest while she works and then returns to guard the nest while she is absent. Towards the middle of the day when the female stops working he relaxes his vigilance and feeds.

The eggs are laid at intervals of one day, usually in the morning before 10 A.M. Two of the nests studied had four eggs and three nests had three eggs. The incubation period in two cases was 16 days. The female begins to incubate when the penultimate egg is laid and gradually increases the time spent on the nest until she is incubating regularly the day after the last egg is laid. She remains on the nest for about 15 to 20 minutes and then goes off to feed for 5 to 10 minutes. During the time the female is on the nest the male is away feeding, usually within 300 yards. After she leaves the nest he returns to his favorite perch and guards till she returns. Her return is greeted with chattering and a quivering wing display. She usually feeds in a place different from his feeding area. In one case she fed across the lake in a section where he never went.

The eggs are pipped two days before hatching. The female carries away the broken shell. The young are blind and nearly naked. Some white down covers the head, the dorsal, and the ventral tracts. Brooding continues for some time but gradually gives way to feeding. The amount of time occupied in brooding decreases as the young grow. In rainy or cold weather the young are brooded nearly continuously. The behavior of the male changes radically when the young hatch, for he now for the first time takes interest in the contents of the nest. He feeds the young, although on the whole not as frequently as the female. However, only the female shields the young from the rain and sunlight. After feeding, the adults usually wait for the young to defecate and then carry away the sac containing the feces. The young remain in the nest for 16 to 17 days. The day before leaving the nest the young start to give the *tik* call of the adults and after one day's practice give it so perfectly that it is indistinguishable to the observer. They exercise the wings frequently at this time. The first day out of the nest the young stay within a few yards of the site; in one case the young came out late in the afternoon and went back into the nest for the night. The second day out of the nest the young leave the nest tree and begin to wander around. The family group now moves about, usually staying near the territory but by no means stays within the territory. The birds do not use the territory as food reserves in any way.

In this region the birds raise only one brood. The fledging success was high, 79 per cent in the nests studied, for 15 young were fledged from 19 eggs laid. During the progress of the nesting cycle the anxiety of the adults increases. After the young have hatched the parents are greatly alarmed by the investigator. There is an interesting difference in behavior between the sexes. When approaching the nest for feeding the young birds, the male, at the nests under observation, alighted on his favorite perch before giving the insect to the young. The female, on the other hand, flew directly to the nest. This difference in habits is probably consequent upon the difference in behavior during the incubation period.

The notes of the species are all loud and harsh. The note *b-zee* is used in the territory by the adults. An unmated bird has a slight difference in this note as described above. A loud harsh *tik* is the most common note and is used on many occasions. The young use it and the adults use it when greeting each other. It seems to be a social note used to keep the birds together and aware of the location of the other member of the pair. This *tik* is used in the tumbling display. A chatter consisting of a series of rapidly repeated *tiks* is used in the greeting ceremony when the female comes back to the nest. When the female goes onto the nest she frequently twitters quietly for a few moments. L. A. Hausmann (1925) comprehensively discusses the

notes of the species, calling attention to the matin song, used early in the morning, and the use of the *kitter* for alarm, chase, and victory.

A peculiar behavior was observed at one nest. The apple tree was infested with tent caterpillars. Frequently the male and sometimes the female swooped down, seized a caterpillar and carried it to a boat which was tied on the edge of the pond about 50 feet away. One day I found 33 caterpillars in the boat. When the boat was not there the birds placed the insects on the dock. No explanation can be suggested for this behavior.

Another observation of interest is that the male in one case slept in the same tree from June 10 until August 16 when observations were discontinued. He frequently called from the top of a nearby tree before diving down to his sleeping place.

Discussion

This study of the Kingbird was undertaken for the purpose of analyzing the relation of the notorious belligerency of the species to the general concept of territorialism. The evidence obtained indicates to the author that the excessive fighting of the *male* is merely exaggerated territorialism. (For the moment we are not concerned with fighting against predators). For an adequate understanding of this interpretation it is desirable to review certain ideas concerning territorialism. For reasons stated elsewhere (Davis, 1940a) it seems necessary to separate the fighting observed into two psychological entities; the fighting over the piece of land (the nest site) and the fighting over the sex-partner. While there are other causes of fighting these are the two which have been grouped under the term of territorialism. Further strength is added to this provisional division by the observations on the Kingbirds. According to this scheme the male defends the territory and also, naturally, the sex-partner. When a male Kingbird is fighting with another Kingbird within his own territory he is simultaneously defending territory and sex-partner. The female defends the sex-partner only. (The phrase "defend the sex-partner" refers to those actions of the male or female which prevent a rival from obtaining the mate. Thus the female drives away other females which might attract the male away). This interpretation explains why the female never drives away other species from the nest; why the behavior of the male is different in intra- and interspecific fighting; why territorial defense (as shown by interspecific fighting) diminishes during the breeding cycle while the defense of the sex-partner is as vigorous after the young are out of the nest as during the building of the nest. It is further in accord with this hypothesis that the territory is secondary to the nest. After the young have fledged, the family group may leave the territory but in spite of this fact, the adults defend the sex-partner with great vigor. This discussion suggests that the interpretation outlined will fit the facts more

closely than an interpretation which combines the fighting for the piece of land and the sex-partner under one psychologic motivation. In summary, this hypothesis suggests that territorialism should be limited to the fighting in defense of the nest site, while sex-partner fighting refers to the defense of the sex-partner.

This scheme differs radically from that of Tinbergen (1939). In my opinion even Tinbergen's data on the Snow Bunting agree with the separation of fighting into territorial and sex-partner categories. Tinbergen considers territorialism as a type of sexual fighting. His definition would exclude defense of territory in the fall but include that which occurs shortly before the formation of the sexual bond. It seems impossible to include the defense of a piece of land as a type of sexual fighting without confusing the distinctly different motivations.

A point of interest concerning the defense of the territory is that the male loses his impulse to fight at evening. About sundown he ceases to patrol the nest site and prepares for retiring. This is in accord with the observations on another Tyrannid, *Muscivora tyrannus*, in Argentina (Davis, 1940b). This species is violently territorial during the day but retires at evening to roosting sites where hundreds of males sleep in harmony; shortly after dawn they have returned to their territories and are defending the nest site.

A problem which assumes great importance in the studies of breeding success and of game management is the occurrence of abortive nests. These nests are built and then for no patent reason deserted. Sometimes the nest is completed and other times only the foundation is started. These studies on the Kingbirds added more data on the occurrence of abortive nests but little information for the analysis of the factors causing abortion. One pair of birds (Dam site) started a nest in an oak tree, worked on it during one morning and then deserted it. In this case it seems likely that the nest site was unsuitable; the tree was high, not near water, and thinly foliaged. The extreme case of abortions was provided by the Myosotis pair. These birds built three nests and deserted each one after completion. The first nest was built in an apple tree which was severely attacked by tent caterpillars and nearly defoliated. This possibly was the reason for desertion. However, it is important to note that two other nests were built in apparently ideal locations and deserted. These facts suggest the importance of some observations on the actions of the female at the first nest. Four days after the first nest was completed she started to "incubate" the empty nest. About four days is the normal interval between the completion of the nest and the start of incubation. The behavior of the female was identical with that of a female incubating eggs. She "incubated" for 15 to 25 minutes; the male guarded in her absence and greeted her in the typical manner when she returned. The incubating rhythm was normal. A possible explanation of these abortions is that no eggs were laid. Which sex was responsible for the deficiency

could not be determined without microscopic examination of the gonads.

The experiences with the dummy birds, although designed to clarify the territorial fighting, also shed light on the problem of discrimination of sex. It will be remembered that both sexes were hostile to the dummy and that the male did not try to copulate with it as occurs in some species (Noble and Vogt, 1935). These facts suggest two interpretations. The less probable is that after pairing the fidelity of the birds is such that no other individual of either sex is attractive to a member of the pair. The more likely interpretation is that the behavior of the other bird must conform to certain patterns in order that the birds may recognize the sex.

Summary

The belligerency of the Kingbird (*Tyrannus tyrannus*) was studied during the summer of 1940 in New York State for the purpose of analyzing the relation of this fighting to the concept of territorialism. Other species of Tyrannidae also are belligerent.

Three types of fighting occur: intraspecific, interspecific, and predator defense.

The intraspecific type occurs between Kingbirds when a stranger intrudes upon the territory of a pair. Both sexes participate and fight throughout the breeding cycle. Experiments with dummy birds showed that both sexes fight against specimens of three species of Kingbirds.

Interspecific fighting occurs between Kingbirds and other species. Only the male fights. He drives away intruders from the nest site under certain specified conditions.

The fighting against a predator differs greatly from the other two types of belligerency. Both sexes go far from the territory to drive away a hawk or Crow.

Observations on the life history show that single birds wander around looking for a mate and, after pairing, select a nest site and territory. The female selects the site, builds the nest, and incubates the eggs. The male assists in feeding the young. The territory is not used for food reserves. Fledging success was 79 per cent for 6 nests. In the two nests observed from laying to fledging, the incubation period was 16 days and the fledgling 16 and 17 days. One pair of birds built three nests, and deserted each in turn, without obvious reason.

Analysis of the belligerency suggests the interpretation that the male defends the territory (nest site) and the sex-partner and the female defends the sex-partner only. The defense of the territory and the defense of the sex-partner are different psychological entities.

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EFFECT OF PHOTOPERIOD ON MOLTING OF FEATHERS[1]

BY S. W. LESHER AND S. CHARLES KENDEIGH

THE regulation of seasonal activities of birds is of great interest and requires correlation of physiological processes with changes in environmental conditions. Considerable attention has been given to the effect of increasing daily photoperiods on the maturing of gonads and the reverse effect of decreasing photoperiods. The present study is an investigation as to the possible effect of changing photoperiods on regulating the time and rate of molting and renewal of feathers.

As early as 1908 Beebe made an experimental attempt to find the cause of molt. He gradually reduced the amount of light per day and increased the food given captive male Scarlet Tanagers, *Piranga erythromelas,* in full breeding plumage. The birds skipped their normal autumn molt. During the winter sudden controlled changes of temperature either to a higher or a lower degree caused all of the birds to lose weight, and a few molted. Among other early workers, Seligmann and Shattock (1914) failed to find a relationship between seasonal assumption of eclipse plumage in the Mallard, *Anas platyrhynchos,* and the spermatogenic function of the testis.

Miyazaki (1934, 1935) was able, by manipulating the photoperiod, to induce three sexual maturations within a year in *Zosterops palpebrosa japonica.* Each time that the photoperiods were reduced from fifteen hours to nine hours per day not only did the gonads regress in size but molting also ensued. Van Oordt and Damste (1935) obtained similar results for the Greenfinch, *Chloris chloris,* in Holland. Cages containing these birds were placed in a cabinet with the door partially open. Each day the door was closed a fraction until at the end of ten days (May 22) it was completely closed. The birds began molting in June and completed the process in July. Since the size of the testes also decreased with the reduction of the photoperiod, Van Oordt and Damste believed that molting may be due to an interacting influence of the gonads and the thyroid.

Very little is known as to the effect of increased photoperiod on the spermatogenic development of birds living in tropical regions where the days are of nearly the same length throughout the year. However, Brown and Rollo (1940), working with whydahs and weaver finches of the species, *Steganura paradisea, Pyromelana franciscana,* and *Vidua principalis,* found that the normal breeding plumage in these equatorial birds could be obtained in one year, instead of the normal two years, by artificially subjecting them to increased periods of daily light. *Steganura* underwent a complete molt before assuming nuptial

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plumage whereas the other two genera renewed only the feathers that changed color. Of direct concern in this connection are the observations of Witschi (1935) that the season of year when plumage changes occurred in the African weaver finch, *Pyromelana franciscana*, one of the species used by Brown and Rollo, was the same for birds caged in his laboratory in Iowa City as it was for birds in Africa, although the seasonal changes in the photoperiod are just reversed in these two localities.

In a recent paper Burger (1941) states that the European Starling, *Sturnus vulgaris*, came into molt under a constant light ration of fifteen to sixteen hours per day. However, Starlings, whose light rations were reduced to nine hours, molted earlier and the new feathers grew more rapidly than in the birds which remained on a constant long photoperiod. On a basis only of observations made in the field, Salomonsen (1939) predicts that the season of molt is controlled by time and rate of changes in temperature rather than length of day. Although the literature is thus suggestive of various controlling influences over molt, it is confusing and often contradictory.

Materials and Methods

We have carried out two experiments (1939–40 and 1940–41) of like nature and observed the reactions of four species. All the birds were trapped on or near the University of Illinois Campus, Urbana, Illinois.

The White-throated Sparrow, *Zonotrichia albicollis*, is a migratory species in this locality. According to Dwight (1900: 196), it goes through two molts each year. The pre-nuptial molt occurs during April and May and involves only body feathers. The post-nuptial molt is complete. It starts in July and extends into late September or early October. The English Sparrow, *Passer domesticus*, a non-migratory species, has no pre-nuptial molt but does have a complete post-nuptial molt beginning in early July and extending into October. The Slate-colored Junco, *Junco hyemalis*, a migratory species, has only the complete post-nuptial molt, starting in July and continuing into September. The Bob-white, *Colinus virginanus*, a non-migratory species, has a very limited head molt in the spring and a complete post-nuptial molt from August to October (Bent, 1932: 17).

The experiments here to be reported were performed in a glass house exposed on four sides to normal daylight, from the north, south, west, and ceiling. The room was sufficiently isolated to eliminate any but minor reflections at night from the street lights and sky. The room was divided into two parts by an opaque partition by which the light over the experimental cages was completely shut off from those containing the control birds.

The cages used for retaining the birds in the first experiment were entirely metal, cylindrical in shape, and covered with fine screen wire. They were one and a half feet in diameter and five feet long. All waste food and excrement were removed from the cages at least twice weekly. New cages were built for the second experiment. The frame work was constructed of wood, then enclosed on the top, bottom, and front with hardware cloth and on the other three sides with pressed wood. The open mesh bottom permitted elimination of waste food and excrement, thereby reducing opportunities for spread of pathogenic bacteria and coccidiosis. Each cage was individually lighted with 150 watt, incandescent, frosted bulbs; two being required for each cage in the first set of experiments but only one in the second. In the second experiment the average light intensity at the level of the roosting perches was 39 foot candles; at the bottom of the cage, 14 foot candles. Two additional metallic cages of the type used in the first experiment were set up to house the unlighted controls for the second experiment.

Fresh water and feed were kept constantly before the birds. At the beginning of the first experiment the food consisted of cracked grain, mostly corn, and fresh lettuce leaves. The birds were weighed at the beginning of the experiment and at irregular intervals thereafter. A noticeable drop in body weight together with a tendency towards droopiness of the birds made it necessary to make changes in the diet. The grain portion was changed to hemp, which is high in fat content, and canary seed. The birds rapidly gained weight and were soon normal. In the second experiment a commercial preparation, which included irradiated yeast and cod-liver oil added to a base of ground sweet meal, was fed daily in addition to the grain mixture to all except the English Sparrows. Fine gravel and cuttle bone were placed in each cage. Every effort was made to eliminate any vitamin deficiency which might influence the results of the experiment. On the later diet the birds remained constant in weight and slightly higher than birds being trapped in the wild at the same time.

At the beginning of both experiments (Table 1) the lights were turned on at two o'clock in the afternoon and continued fifteen minutes beyond sunset. Each day the light period was increased fifteen minutes except in the controls. As the length of normal day light at this time of the year was decreasing at the rate of two minutes a day, actually the artificial lights were left on for an additional seventeen minutes daily. After the artificial day reached its full length of fifteen hours, which is comparable to the maximum length of a summer day, the lights were turned on and off manually at the same time each day. The time the birds were held at the full fifteen-hour day was 45 days in the first experiment and 139 days in the second. After all molt due to increased photoperiod had ceased and the birds had reached an apparently constant physiological state, the length of day was shortened.

TABLE 1

DATA ON TIME RELATIONS OF EXPERIMENTS

(Molt is here used to include the period of feather loss only)

	First Experiment	Second Experiment
Date experiment begun	December 4, 1939	October 14, 1940
Date photoperiod of 15 hours attained	December 23, 1939	November 4, 1940
Date partial molt started	December 25, 28, 1939	November 10, 1940
Date partial molt ended	January 8, 1940	November 24, 1940
Date shortening of photoperiod started	February 6, 1940	March 23, 1941
Date photoperiod of 9 hours attained:		
Cage A	February 6, 1940	June 2, 1941
Cage B	February 29, 1940	April 15, 1941
Cage C	February 29, 1940	March 23, 1941
Cage D	April 17, 1940	Held at 15 hours
Cage E	Controls	Held at 15 hours
Cage F	Controls	March 23, 1941
Cage G		March 23, 1941
Cage H		April 15, 1941
Date complete molt started:		
Cage A	February 16, 1940	April 15, 1941
Cage B	February 21, 1940	April 5, 1941
Cage C	February 24, 1940	March 30, 1941
Cage D	March 4, 1940	Held at 15 hours
Cage E	Controls	Held at 15 hours
Cage F	Controls	March 30, 1941
Cage G		March 30, 1941
Cage H		April 8, 1941
Date complete molt ended:		
Cage A	February 25, 1940	June 8, 1941
Cage B	March 19, 1940	April 29, 1941
Cage C	March 19, 1940	April 11, 1941
Cage D	May 11, 1940	Held at 15 hours
Cage E	Controls	Held at 15 hours
Cage F	Controls	April 11, 1941
Cage G		April 11, 1941
Cage H		May 2, 1941

This shortening of the photoperiod was at various intervals to determine any possible effect on the rapidity of the produced molt (Table 2).

EFFECT OF INCREASED PHOTOPERIODS

First Experiment—Two days after the added light had increased the photoperiod to fifteen hours in the first experiment, the White-throated Sparrows in cages A and B (Table 2) began dropping feathers from the anterior region of the ventral tract. Three days later the birds in cage D began losing feathers from the same tract. The molt progressed from anterior to posterior in both the ventral and spinal tracts with the molt beginning in the spinal tract soon after the first signs of molt in the ventral tract. Feathers also were dropped from the posterior region of the capital or head tract. No remiges or rectrices were

TABLE 2

DISTRIBUTION OF BIRDS IN DIFFERENT CAGES

CAGES	White-throated Sparrow	English Sparrow		Slate-colored Junco	Bob-white Female	Rate photoperiod reduced from 15 to 9 hours
		Male	Female			
	First experiment					
A	8					Immediately
B	8					15 min. daily
C		1	8			15 min. daily
D	8					15 min. daily
E		4	4			Control
F	5					Control
	Second experiment					
A	8					5 min. daily
B	8					15 min. daily
C	8					Immediately
D	3			3		Held at 15 hours
E		8				Held at 15 hours
F		4	4			Immediately
G					1	Immediately
H			8			15 min. daily
I		4	4			Control
J		4	4			Control

molted. The White-throated Sparrows of the unlighted control cage (F) showed no signs of molting. The testes of six birds, sectioned and examined microscopically during this partial molting period, were in complete spermatogenic development. The molt was short in duration and by the end of the second week was completely over (Figure 1). None of the English Sparrows showed any sign of molt although the blackening of the bill in the males showed that the gonads were increasing in size in the expected manner.

Second Experiment—In the second experiment, six days after the photoperiod had reached its full length of fifteen hours, the White-throated Sparrows began molting. The molt in this experiment was more extensive than in the first experiment. This time it included the rectrices and a few scattered secondaries in all except the birds in cage D, which were birds that were carried over from the first experiment, and five birds in cage A. The molt progressed rapidly to its peak in eleven days, then ceased entirely after another three days. The gonads of those birds examined at the start and during the molt were in complete spermatogenic development. During this period of extended day length and up to the time that the light was reduced, the White-throated Sparrows showed many signs of mating behavior and often attempted copulation. Early in the morning and again at night before the lights were turned off, their singing was loud and natural.

The Bob-white (cage G) molted only a few feathers around the head and throat. One hundred twelve days after the photoperiod reached fifteen hours, this solitary female laid an egg and followed this with one every six days for four successive weeks, until the photo-period was

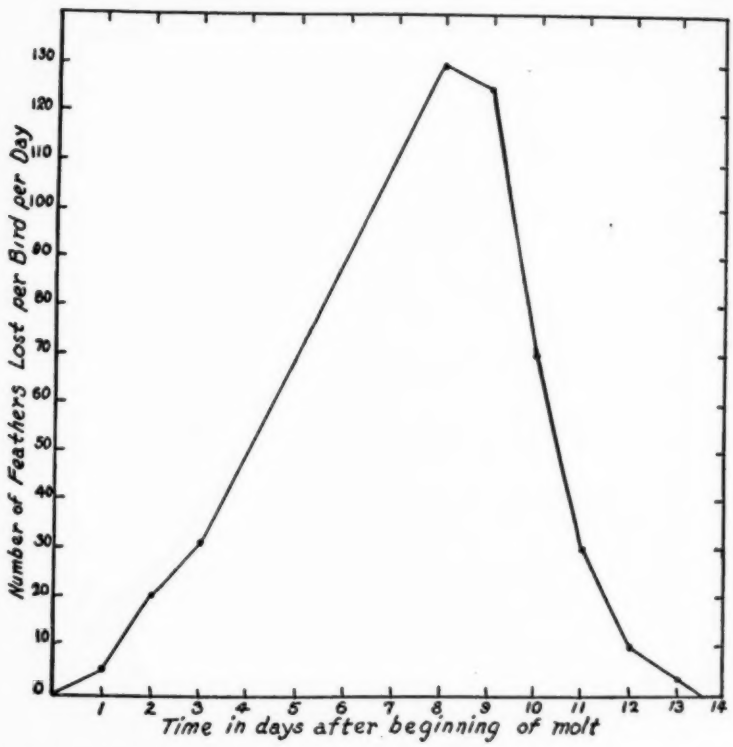

Figure 1. Average rate of feather loss in White-throated Sparrows during a partial molt induced in two experiments by increasing the daily photoperiod to fifteen hours.

reduced. None of the control White-throated Sparrows, nor any of the English Sparrows, nor the Slate-colored Juncos showed any sign of molt.

Effect of Decreasing Photoperiods

First Experiment—All of the birds in the first experiment, both White-throated Sparrows and English Sparrows, molted as the day length was decreased. The beginning of complete molt and the rate of progress appeared to depend upon the rate of the reduction in daily light. Birds reduced suddenly on February 6 from fifteen to nine hours light (Table 2, cage A) began molting ten days later. The molt began

with the loss of primaries but thereafter the feathers fell so rapidly and in such great numbers that it was impossible to trace any definite sequence. The molt was completely over nine days after it began (Figure 2). All birds lost weight rapidly and by February 29 all were dead. The shortened feeding hours together with the sudden molt and the energy requirements for growing new feathers were apparently too great a drain on their body reserve.

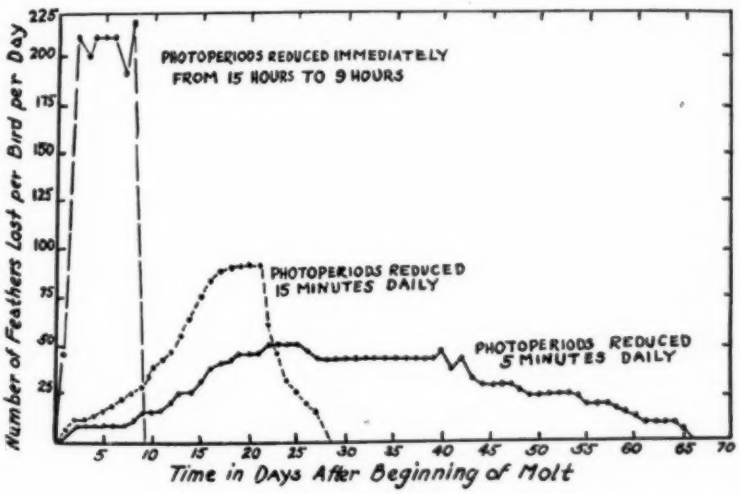

Figure 2. Comparison of rate and duration of feather loss in the complete molt of English and White-throated Sparrows in the first experiment, induced by shortening the daily photoperiod at different rates.

The birds subjected to a light reduction of fifteen minutes daily beginning February 6 (cages B, C), began their molt 15 days later in the White-throated Sparrow and 18 days later in the English Sparrow. The molt in both species was still irregular in sequence but extended over a period of four weeks. In spite of the more gradual molt, the weight of all birds decreased, although they recovered and developed new feathers.

The molt of the birds reduced from fifteen hours to nine hours at the rate of five minutes daily (cage D) began 27 days after the beginning of the light reduction and more nearly approached the normal molt as it occurs in nature. The weight of the birds dropped slightly. The new feathers quickly replaced the ones lost so that the birds never acquired the ragged appearance such as characterized the more rapid molt in the other cages. The count of feathers lost per day (Figure 2) is only an approximate one as some feathers were eaten by the birds and

others were lost. The total feather loss was 1500 per bird in those exposed to an immediate decrease in the photoperiod, 1700 per bird in those exposed to a fifteen minute daily decrease, and 1900 per bird in those exposed to the five minute daily decrease. This is to be compared to a total loss about 740 feathers in the partial molt (Figure 1).

. *Second Experiment*—The factors made evident by the first experiment were confirmed by the second. In the birds exposed to a suddenly shortened photoperiod of nine hours (Table 2, cages C, F, G) the molt began almost simultaneously in the White-throated Sparrows, English Sparrows, and Bob-white; but it was more intense with the Bob-white and English Sparrow than with the White-throated Sparrow. The molt began seven days after the photoperiod was shortened. The loss of feathers was not as extensive as in the first experiment and at the end of the twelfth day it ceased. The Bob-white and White-throated Sparrows were given vitamin food with their regular grain rations and suffered no ill effects from their molt. The English Sparrows were fed only their grain rations and though they appeared to be more sturdy, three of the five birds were not able to recover from the effects of the heavy molt (Table 3).

TABLE 3

AVERAGE WEIGHT OF BIRDS IN GRAMS AT DIFFERENT TIMES IN THE SECOND EXPERIMENT

CAGES	A	B	C	D[1]	D[2]	E	F	H
Just trapped, short days	26.2	26.5	24.1	25.1 (1939)	17.3	26.2	25.3	26.1
After one week in captivity	25.9	26.1	23.9	....	17.1	25.4	25.0	25.7
At stage of photoperiod increase represented by 12 hours of daily light	26.3	26.9	24.1	29.0	18.0	25.7	25.2	26.0
After one week in 15-hour photoperiod	27.1	28.0	26.3	29.4	21.0	27.1	26.1	26.0
During period of partial molt	25.7	26.2	24.8	29.5	21.2	27.1	26.3	26.1
After four weeks in 15-hour photoperiod	27.7	28.5	26.6	30.1	21.2	27.2	26.5	26.2
At beginning of complete molt on decreased photoperiod	27.6	28.6	26.6	(29.9)[3]	(20.9)	(27.1)	26.4	26.3
At end of complete molt	25.4	25.7	23.1	(29.3)	(18.9)	(24.0)	23.1	24.2

[1] White-throated Sparrows only.
[2] Slate-colored Juncos only.
[3] Weights in parenthesis are of birds that did not molt but taken at the same time as for birds in other cages that did molt.

The White-throated Sparrows and English Sparrows subjected to reductions in day length by fifteen minute (Table 2, cages B, H) and five minute intervals (Cage A) went through a more gradual

and orderly molt, but this was not as complete a molt as in the first experiment. The birds were in excellent condition but suffered some decrease in weight (Table 3). The birds subjected to photoperiods reducing at fifteen minutes per day began their molt 13 to 16 days after the start of the reduction; those subjected to photoperiods reducing at five minutes per day began 23 days after the start of the experiment.

In addition to the cages subjected to a reduction in photoperiod, two cages (D, E) were kept at a constant fifteen-hour day. As the days were rapidly increasing in length, the amount of added artificial light was reduced each day at a corresponding rate. Neither group of birds molted. The White-throated Sparrows skipped the normal partial molt which occurs in spring.

The three White-throated Sparrows retained from the first experiment (Cage D) were more uniform and natural in their molt than those freshly secured for the second experiment. Since these three White-throated Sparrows were trapped in October, 1939, they had experienced three partial and two complete molts, namely: an induced partial molt beginning December 25, 1939; an induced complete molt beginning February 16, 1940; a partial molt in May, 1940; a normal complete molt in August, 1940; and an induced partial molt beginning November 10, 1940.

Many remiges and rectrices of the White-throated Sparrows, which replaced feathers molted during the complete molts, came in as albino feathers. All the feathers in the other tracts were normal in color. This occurred in forty per cent of the birds of this species, but did not occur in the English Sparrow, Slate-colored Junco, or Bob-white, although these birds were under comparable conditions. No explanation can be advanced for this phenomenon at the present time.

Discussion

These experiments demonstrate definitely that, at least under certain experimental conditions, changes in the length of the daily light period will induce molt and renewal of feathers at other than the normal time of year. Not only that, but the rate at which the photoperiod is reduced will affect the time the molt is initiated and the rapidity at which the feathers are lost. The inference is not justified at the present stage of the investigation, however, that the season and regulation of molt is determined only by changes in the photoperiod. As yet we have only started the investigation of the influence of changes in temperature, which Salomonsen (1939) claims to be the primary factor, and other factors may also be important.

The molt brought about by the reduction in the photoperiod occurred in three species and was more or less complete (less so in the second than in the first experiment), as is true for natural conditions

when birds undergo their post-nuptial molt in the autumn. The molt produced by increasing the photoperiod occurred only in those species where a pre-nuptial spring molt is known to occur under natural conditions and not in the others. This molt in nature is a partial one, and this was true for the artificially produced molt, except in the second experiment with many of the White-throated Sparrows when it was abnormally heavy.

The total time required for birds to lose their feathers and then completely replace them was nearly the same (65 to 73 days) regardless of the rapidity at which the feathers were lost (Figure 3). This

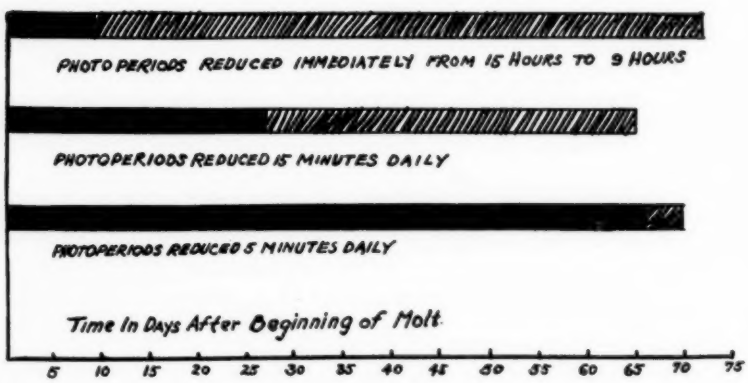
PHOTOPERIODS REDUCED IMMEDIATELY FROM 15 HOURS TO 9 HOURS
PHOTOPERIODS REDUCED 15 MINUTES DAILY
PHOTOPERIODS REDUCED 5 MINUTES DAILY
Time In Days After Beginning of Molt
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

Figure 3. Comparison of time required to lose old feathers and to grow new ones in English and White-throated Sparrows exposed in the two experiments to daily photoperiods decreasing at different rates. The solid portion of the bar represents the period during which the feathers were lost, while the cross-hatched portion is the additional period required for the complete growth of new feathers.

would seem to indicate that the feather papilla begins growth very soon after the photoperiod is reduced and proceeds at nearly the same speed regardless of the rate at which the photoperiod is decreasing. It is possible that loss of feathers and growing of new ones are somewhat independent processes but both related to changing day lengths.

The intermediary mechanism by which length of day produces its effect upon the feather papilla is not known. Length of day supposedly influences the size of the gonads by way of the pituitary gland, and the gonadotropic hormones of the pituitary have received considerable study. Perhaps the pituitary gland is also involved in producing molt, but there is very little evidence for such a direct relationship. There is as much reason to believe that the thyroid glands may be involved as the gonads, but it is realized that the activity of both of these glands is affected in turn by the pituitary. In these experiments the testes

varied in size and development with increasing and decreasing lengths of light period in the manner to be expected. It might be reasoned that they regulated the loss and renewal of feathers. Molt occurred in females similarly as in males, although very likely their ovaries did not reach as complete development as did the testes of the males, except in the Bob-white. It is very possible that the influence of the photoperiod over gonad development and feather molt is entirely independent. We have made plans to test this point with castrated birds. Contrary to what Burger (1941) found, molt did not occur in our birds maintained continuously at the fifteen-hour day.

Length of day may affect molt through some other mediation than by direct hormone stimulation. Changes in nutritive balance may be important, as Beebe (1908) hinted. In future experiments we hope to measure rate of energy metabolism at various stages in this molting cycle, but in the present experiments reliance had to be placed solely on changes in weight. With longer days and shorter nights, length of time available for feeding is increased, and the corresponding daily period without food is shortened. The reverse is true with shortening days and lengthening nights. Table 3 shows a strong tendency for birds to increase in weight when subjected to a fifteen-hour photoperiod. The White-throated Sparrows that underwent a partial molt on the long photoperiods decreased in weight at this time, but not as much as did all birds that underwent a complete molt on the shortened photoperiods. The results are not entirely consistent as the Slate-colored Juncos in cage D and the male English sparrows in cage E also decreased in weight, although they were being held at a fifteen-hour light period and were not molting. The average weights of the control birds in cage I, taken eight times during the course of the experiment, varied only between 24.9 and 25.3 grams. Even if a correlation is fully established between loss in weight and molt, this will not demonstrate which is the cause and which is the effect. Perhaps both functions are independently affected, but the growth of feathers must certainly be energy demanding. The death of all birds when thrown into full molt in the first experiment by the sudden decrease of the photoperiod from fifteen to nine hours would seem to demonstrate this requirement.

The present paper is a preliminary report, but the results obtained to date are suggestive, promising, and leading toward future researches.

Summary

1. White-throated Sparrows and a Bob-white, which normally go through a partial pre-nuptial molt in spring as the days are increasing in length, were forced to molt out of season by artificially increasing the length of day, and this was followed by a new growth of feathers.

2. White-throated Sparrows, English Sparrows, and a Bob-white, all of which have a complete post-nuptial molt as days decrease in

length in late summer and autumn, were forced into a similar molt out of season by artificially reducing the length of day to which they were exposed. This was followed by a new growth of feathers.

3. The time for beginning the complete molt and the rate at which the feathers were lost were accelerated by increasing the rate at which the length of day was artificially decreased.

4. The total time (65 to 73 days) required to molt feathers and completely grow new ones was approximately the same at all rates of decrease in the photoperiod and irrespective of the rate at which the feathers were lost.

5. The weight of the birds increased when they were placed on a better balanced diet and when they were subjected to longer photoperiods, but it decreased during the progress of molt and renewal of feathers.

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A COLLECTION OF BIRDS FROM THE LA SAL MOUNTAIN REGION OF SOUTHEASTERN UTAH

BY WILLIAM H. BEHLE

AS part of a continuous biological survey of the state, a party from the University of Utah, under the leadership of Dr. A. M. Woodbury and the author, made a trip of ten days duration during early April of 1938 to the La Sal Mountain region of southeastern Utah. This was in the nature of a reconnaissance trip and a general collecting trip but nevertheless the author, assisted by various members of the party, secured and prepared as study skins 176 birds. This collection has much to offer in the way of distributional and systematic data. In view of the fact that Utah and neighboring states comprise perhaps the least known area of the country from the standpoint of birds, it seems well to place the data on record as a contribution to our knowledge of the birds of the state.

The time chosen for the trip was determined by the spring vacation at the University and thus was too early for gathering much data on breeding birds. This was partly compensated for by our obtaining specimens of migratory species that probably would not have been encountered later. We left Salt Lake City April 1, 1938 and made our first camp in Block Canyon near Kane Spring, San Juan County, some 19 miles south of Moab, Utah. The elevation at this point was about 5,400 feet. We had hoped to be able to collect high in the mountains in the coniferous forest but snow drifts blocked most of the roads. As a result we established base camp at the above mentioned locality and for several days worked in the surrounding juniper-piñon forest or in canyon bottoms where occasional cottonwoods were found. On April 7 and again on April 8 we reached the higher oak belt and got into some scattered groves of western yellow pine at 8,000 feet. Then on April 9 we moved to Moab and collected along the Colorado River near the town and on April 10 returned to Salt Lake City. The specimens of birds comprising the collection represent 43 species and subspecies. This report is based solely on the collection; no sight records are included. All localities mentioned are in San Juan County unless otherwise stated.

Accipiter velox velox (Wilson). Sharp-shinned Hawk. One specimen, a female, was collected among yellow pines at an elevation of 8,000 feet, 5 miles northeast of the La Sal post office on April 8.

Falco sparverius sparverius Linnaeus. Eastern Sparrow Hawk. Two females collected in Block Canyon, near Kane Spring, 19 miles south of Moab, 5,400 feet, one on April 4, the second on April 6.

Oxyechus vociferus vociferus (Linnaeus). Killdeer. One male was shot on April 5 near our Block Canyon camp.

Otus asio mychophilus Oberholser. Grand Canyon Screech Owl. Two females were collected from holes in cottonwoods along the canyon bottom near our Block Canyon camp (April 3 and 5). The first one was kept alive several days in camp during which time it laid two eggs. When we dissected the bird we found three other large eggs which evidently would soon have been laid.

H. C. Oberholser has recently (*Jour. Wash. Acad. Sci.*, 27, 1937:356) described a new subspecies of Screech Owl, *Otus asio mychophilus*, with a range as follows: "Northern Arizona and southern Utah, north to north central Utah (Provo); west to southwestern Utah; south to northern Arizona; and east to central eastern Utah (Moab)." The two La Sal specimens, as compared with one topotype of *mychophilus* at hand from Grand Canyon Village, are a little browner on the back and more heavily streaked below. The heavy streaking on the breast is one of the distinguishing characters between *mychophilus* and both *inyoensis* and *cineraceus*. The La Sal specimens, as compared with representatives of *cineraceus*, are also larger and darker. Specimens from northern Utah which seem to be closest to *inyoensis* have the vermiculations on the underparts less prominent, hence the mass effect is of a lighter hue. This is also an accompaniment of the less heavily streaked condition.

Bubo virginianus occidentalis Stone. Montana Horned Owl. A female was taken at the Block Canyon base camp on April 6, 1938. Its nest was discovered April 2 and kept under observation until the bird was collected. It was located on a rocky ledge some 12 feet above the canyon bottom. On April 3 at 8:00 A.M. when the nesting site was visited one bird was on the nest and its mate was flushed from a piñon pine 25 yards from the nest. From numerous pellets at the base of the tree it would seem that this tree was a regular roosting site. When finally the bird on the nest was shot, it proved to be the female with a pronounced brood patch and a thick layer of oily fat beneath the skin of the brood patch. The mate was not secured, seemingly having deserted the area. Only one egg was in the nest. It rolled out and broke, exposing a large embryo.

The single specimen seems to be intermediate between the races *occidentalis* and *pallescens*, perhaps closer to the former.

Asio wilsonianus (Lesson). Long-eared Owl. A female was collected at Big Indian Wash, 10 miles north of Monticello, April 3.

Colaptes cafer collaris Vigors. Red-shafted Flicker. A female was taken at the Block Canyon location April 4.

Sphyrapicus varius nuchalis Baird. Red-naped Sapsucker. A total of five specimens collected; 2 males and a female from Block Canyon on April 4 and 5; a female taken at 8,000 feet, 5 miles northeast of the La Sal post office, April 8; and a male from Moab, 4,870 feet, Grand County, April 9.

Dryobates pubescens leucurus (Hartlaub). Batchelder's Woodpecker. A single male collected in Block Canyon, April 7.

Sayornis saya saya (Bonaparte). Say's Phoebe. Two specimens, a male and female collected in the Block Canyon area, April 2 and 6.

Otocoris alpestris occidentalis McCall. Montezuma Horned Lark. Twelve Horned Larks were collected from three localities as follows: 3 males and one female from midway between Woodside and Greenriver, Emery County, April 1; 6 males and one female from 5 miles south of Crescent Junction, Grand County, April 9; and one female from Dry Valley, San Juan County, 33 miles southeast of Moab, April 4. All were breeding birds.

These specimens are indistinguishable from breeding topotypes of *occidentalis*.

Cyanocitta stelleri diademata (Bonaparte). Long-crested Jay. Two males, both taken in the yellow pines, 8,000 feet, 5 miles northeast of the La Sal post office, April 8.

Aphelocoma californica woodhouseii (Baird). Woodhouse's Jay. Two females from the Block Canyon locality, April 2 and 4.

Cyanocephalus cyanocephalus (Wied). Piñon Jay. One female collected at the Block Canyon locality, April 4.

Nucifraga columbiana (Wilson). Clark's Nutcracker. A female was taken at the Block Canyon locality, 5,400 feet, April 4 and a male April 7 at an elevation of 8,000 feet 5 miles northeast of the La Sal post office.

Penthestes gambeli gambeli (Ridgway). Mountain Chickadee. Two males collected at 8,000 feet, 5 miles northeast of the La Sal post office, April 7.

Baeolophus inornatus griseus (Ridgway). Gray Titmouse. Having in mind that the subspecies in the area might be *plumbescens* described by Grinnell from Silver City, Grant County, New Mexico, but ranging as far north as the San Francisco Mountains of northern Arizona, a series of 22 titmouses, 9 males, 13 females, was obtained from the Block Cayon area. The type locality of *griseus* is Iron City, Iron County, Utah, a town and iron furnace site long deserted, but in the Great Basin portion of Utah. The series from the La Sal region is, however, clearly of the race *griseus,* showing no approach to the New Mexico race.

Psaltriparus minimus plumbeus (Baird). Lead-colored Bushtit. A series of 18 specimens, 11 males and 7 females, was secured at the Block Canyon locality, a few each day. They are typical of *plumbeus,* having the pinkish cast on the flank feathers and brown cheeks. As compared with California specimens, there seems to be a little more brown back of the forehead.

Sitta carolinensis nelsoni Mearns. Rocky Mountain Nuthatch. On April 7, two males were shot from yellow pines, 5 miles northeast of the La Sal post office, 8,000 feet.

Sitta pygmaea melanotis van Rossem. Black-eared Nuthatch. Two males and a female are represented in the collection, having been taken on April 7 and 8, 8,000 feet, 5 miles northeast of the La Sal post office.

Thyromanes bewickii eremophilus Oberholser. Baird's Wren. Three males are present, two from the Block Canyon locality, taken April 3 and 5 and one from 5 miles northeast of the La Sal post office. 8,000 feet, April 7.

Telmatodytes palustris plesius (Oberholser). Western Marsh Wren. A single specimen, a male, from Moab, Grand County, April 9.

Catherpes mexicanus conspersus Ridgway. Cañon Wren. A male was taken at Block Canyon, April 4 and a male and female at Moab, Grand County, April 9.

Salpinctes obsoletus obsoletus (Say). Common Rock Wren. A pair was taken April 5 at the Block Canyon locality.

Oreoscoptes montanus (Townsend). Sage Thrasher. A single female was shot in the vicinity of the Block Canyon camp on April 5.

Turdus migratorius propinquus Ridgway. Western Robin. One female was taken at the Block Canyon locality April 5 and a pair was secured from 5 miles northeast of the La Sal post office, 8,000 feet, on April 8.

Sialia mexicana bairdi Ridgway. Chestnut-backed Bluebird. Two males were collected among yellow pines at 8,000 feet, 5 miles northeast of the La Sal post office, April 8.

Sialia mexicana occidentalis Townsend. Western Bluebird. One male was secured among the junipers at our Block Canyon camp, 5,400 feet, April 6. It is significant to note that this individual, evidently a migrant, occurred in the lowlands while the preceding two, probably representing the resident race, were found in the habitat where bluebirds of this species normally nest.

Myadestes townsendi (Audubon). Townsend's Solitaire. A female was taken 5 miles northeast of the La Sal post office, 8,000 feet, April 7.

Agelaius phoeniceus utahensis Bishop. Utah Red-wing. While at Moab on April 9 we saw many Red-wings and secured 11 males. These are identical in their characters with birds from the vicinity of Salt Lake City and are referable to the race *utahensis* recently described by Bishop (*Trans. San Diego Soc. Nat. Hist.,* **9,** No. 1, 1938:1–4).

Carpodacus cassinii Baird. Cassin's Purple Finch. One male was collected at 8,000 feet, 5 miles northeast of the La Sal post office on April 8.

Carpodacus mexicanus solitudinus Moore. Six males were collected throughout the week at the Block Canyon camp. The specimens were borrowed by Robert T. Moore in connection with his revision and were pronounced to be intergrades between his new race *solitudinus* and the more eastern race *frontalis* as he limits the range of the latter. (See *Condor*, 41, 1939: 191.)

Spinus pinus pinus (Wilson). Northern Pine Siskin. Two females were collected on April 3 and 4 at the Block Canyon locality.

Loxia curvirostra benti Griscom. Red Crossbill. A single male which was shot from a flock among yellow pines at 8,000 feet 5 miles northeast of the La Sal post office on April 8 has been identified by Griscom as an intergrade between the races *benti* and *grinnelli*.

Pipilo maculatus montanus Swarth. Spurred Towhee. This species was abundant in the oak chaparral at 8,000 feet, 5 miles northeast of the La Sal post office. On April 7 and 8 a series of 22 specimens were obtained, of which 14 are males.

Junco hyemalis hyemalis (Linnaeus) Slate-colored Junco. A male was taken at 8,000 feet, 5 miles northeast of the La Sal post office on April 7.

Junco hyemalis cismontanus Dwight. Cassiar Junco. A male and female were taken April 3 and 6 at the Block Canyon locality among mixed flocks of juncos. These specimens were submitted to Dr. Alden H. Miller who commented that they showed more than the usual amount of *oreganus* characters.

Junco oreganus montanus Ridgway. Montana Junco. These were numerous but only three were collected, all males, on April 3 and 7, from the Block Canyon locality.

Junco oreganus mearnsi Ridgway. Pink-sided Junco. Two males were taken at 5,400 feet in the vicinity of our Block Canyon camp April 3 and 6 while two other males were taken at 8,000 feet April 7, 5 miles northeast of the La Sal post office.

Junco caniceps caniceps (Woodhouse). Gray-headed Junco. Six typical specimens and two hybrids with *mearnsi* are represented in the collection. Five male *J. c. caniceps* were collected at various times at the Block Canyon locality and one male was taken 5 miles northeast of La Sal at 8,000 feet, April 7. The male hybrid was also taken at this high locality April 8, but the female lower down in Block Canyon on April 6.

Zonotrichia leucophrys gambelii (Nuttall). Gambel's Sparrow. Two males were obtained April 5 at Block Canyon. They were first year birds undergoing a molt.

Melospiza lincolnii lincolnii (Audubon). Lincoln's Sparrow. Three males and 2 females were shot along the river bottom land at Moab, 4,000 feet, Grand County, April 9. These were migrant birds, not of the resident race *P. l. alticola* as Miller and McCabe (*Condor*, 37, 1935:144–60) have worked it out. These birds are large in size, too heavily streaked to be of the summer resident race and a few represent the reddish extremes that are more common in the northern race. Considerable variation is shown among the lot but it all falls within the limits of variability of the race *lincolnii*.

Melospiza melodia fallax (Baird). Mountain Song Sparrow. Three females were secured near the Block Canyon locality on April 4 and 5 and 4 others of both sexes were collected at Moab, Grand County, April 9. All are fairly typical of *fallax*.

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AN EXPERIMENTAL STUDY OF BROWSE AS A WINTER DIET FOR PRAIRIE CHICKEN

BY F. N. HAMERSTROM, JR., FRANK HOPKINS, AND ANTON J. RINZEL

FOOD habits studies begin as lists of what an animal eats, but soon become measurements of the nutritive values of the different foods. Examples of food lists are too numerous and too well known to need mention; examples of nutritive measurements are still scarce. Leopold (1933:258–72) set up a classification of wildlife foods based on preference as a measure of quality; a few others have measured quality directly by bio-assay, particularly for foods of Bob-white (Errington 1931, 1933, 1936), Ring-necked Pheasant (Errington, 1936, 1937), and deer (Maynard *et al,* 1935; Davenport, 1937; Nichol, 1938). Such studies as these seek to answer the question, "Will this food, or that combination of foods, keep this particular animal alive and in good condition?" There is an obvious need, from the standpoint of wildlife management, for direct measurement of the nutritive values of more foods of more animals.

The Prairie Chicken [1] is a case in point. As a member of the grouse family, can it, like most of the others, live through the winter on a diet of browse alone? The issue has been a controversial one for many years.

The question is open to two approaches, one observational, the other experimental.

Diet: Observational Data

According to Schmidt's (1936) report and the unpublished notes of F. N. Hamerstrom and Frances Hamerstrom, the main winter foods in Wisconsin are:

Grains—corn, buckwheat, soybeans, barley, oats, rye.

Weed seeds—many kinds, such as lesser ragweed (*Ambrosia artemesiifolia*), climbing false buckwheat (*Polygonum dumetorum*), and other members of the same genus, green foxtail (*Setaria viridis*).

Browse—white birch (*Betula alba* var. *papyrifera*), bog birch (*Betula pumila* var. *glandulifera*), hazel (*Corylus americana*), aspen (*Populus tremuloides*), sweet fern (*Myrica asplenifolia*), and blueberry (*Vaccinium pennsylvanicum*) are most heavily used; to a lesser degree, willow (*Salix* spp.), maple (*Acer* spp.), elm (*Ulmus* spp.), pine (*Pinus banksiana, P. resinosa,* perhaps also *P. strobus*), and apple (*Pyrus malus*).

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* A cooperative project by the Department of Wildlife Management of the University of Wisconsin and the Wisconsin Conservation Department.

[1] *Tympanuchus cupido americanus.*

Fleshy fruits and mast—in winter, limited mainly to rose hips (*Rosa* spp.) and acorns (*Quercus* spp.)

Greens—such green leaves as they can get, as dewberry (*Rubus* sp.), clovers, and sometimes grass.

Schmidt (1936) found that the Prairie Chickens he was studying lived almost entirely on buds when the temperature was above zero, but ate, and probably needed, corn at temperatures below zero; the Hamerstroms found Prairie Chickens regularly eating corn and other grains and weed seeds through the autumn and mid- and late winter, but for a time in early winter found them absent from their accustomed grain and weed fields.

It is likewise clear from observation alone that Prairie Chickens are found in greatest numbers in farming regions, not only in Wisconsin but in the North Central States generally. Not in all farming regions, to be sure, for most are now so completely under cultivation that too little cover remains. Too much cultivation has driven Prairie Chickens from most of their original range; too little is having the same effect in parts of their acquired northern range, where areas once open are growing up solidly to brush (Hamerstrom, 1939).

Although Prairie Chickens are found in farming regions and are known to eat grains, it does not follow that cultivated crops are *essential* foods. Farm lands are open lands, and openness is an essential part of Prairie Chicken range. It may even be that good farming soils are good Prairie Chicken soils.

The fact that cultivated fields are used consistently as feeding grounds comes closer to the point. Weed seeds are eaten in quantity, particularly in autumn, but in the northern states cannot be relied upon as winter food because of snow cover. Of the two sorts of winter food, cultivated grains therefore seem to be the more important. This argument is supported by the fact that the Prairie Chickens' southward migration in winter (Cooke, 1888:104–6; Leopold, 1931:173–5) was markedly lessened by the introduction of corn into the northern states (Spurrell, 1917; Swanson, 1940).

On the other hand, we have reports of a few instances in which a few Prairie Chickens winter in places that have little or no winter grain to offer. Our two best authenticated examples are a flock in Oneida County, Wisconsin (Schmidt, 1936), and the Seney Migratory Waterfowl Refuge, Germfask, Michigan (John H. Steenis, 1940, *in litt.*).

Diet: Experimental Data

Since the observational approach does not present a clear answer, we tried a feeding experiment on captive Prairie Chickens in the winters of 1939 and 1940.

The purpose of the experiment was to determine whether a diet of browse (i.e., buds and catkins) alone, in unlimited quantity and freely selected, could maintain the weight of Prairie Chickens in winter.

Thirty-eight wild Prairie Chickens (22 in 1939 and 16 in 1940) were trapped and sent to the State Experimental Game and Fur Farm

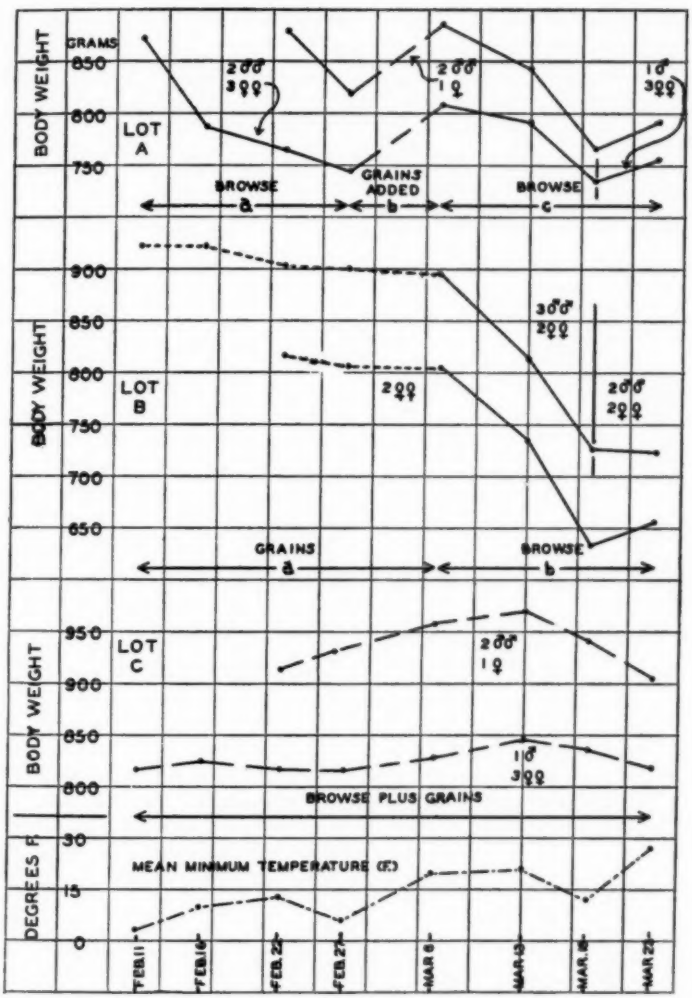

Figure 1. Effect of browse diet on Prairie Chickens, as shown by body weight: 1939.*

* After a bird died during an experiment, the succeeding weights were corrected to permit the weight curves to be unbroken, by adding (or subtracting) average weight changes for the remaining live birds to the average weight of all birds of that lot at the time the individual died.

at Poynette, where they were brailed and held on browse plus grains for seven to ten days to accustom them somewhat to captivity. They were then divided into lots of about eight birds each, half males and half females. Each lot was held in a 12 x 12 foot pen which was open to the weather except for an 18 inch baseboard and a few small shelters, roofed but open to the weather on two sides.

One lot was kept each year on browse plus grains to serve as controls. One lot each year was fed on browse alone, then on browse plus grains, then (in 1939 but not in 1940) on browse alone again. One lot started the 1939 experiment on grains without browse, then was shifted to browse alone. All birds were weighed about every five days, except during the initial holding period.

For details concerning the kinds of browse and the manner of feeding, see below[2]; dates and the exact numbers of birds per lot are given in Figures 1 and 2. Temperature records were provided by the

TABLE 1

EFFECT OF DIET OF BROWSE ALONE, AS SHOWN BY BODY WEIGHT

Lot	Diet	No. birds	Average Weight per Bird					Average period of time
			At start	At finish	Max. loss below starting average	Max. recovery	Max. gain above starting average	
Aa	Browse	8	89.2%	78.8%	10.4%		0.0%	11.9 days
Ac	Browse	8	85.4%	78.6%	9.2%	2.4%*	0.0%	16.4 days
Bb	Browse	7	90.2%	73.0%	17.8%	0.6%**	0.0%	16.3 days
Da	Browse	8	93.6%	80.2%	13.4%		0.0%	10.0 days
Average	Browse	7.75	89.6%	77.8%	12.5%	0.7%	0.0%	13.6 days

* 7 birds.
** 6 birds.

[2] Experimental diets:

(a) Browse—(1) white birch, bog birch, hazel, sweet fern, aspen, blueberry, grit; (2) willow, elm, maple, river birch (*Betula nigra*), alder (*Alnus incana*), rose hips and fruiting heads of smooth sumac (*Rhus glabra*). River birch sometimes had to be substituted for white birch in 1939, but white birch was used throughout the 1940 experiment.

(b) Grains—yellow corn, buckwheat, soybeans, oats, barley, wheat, and rye; grit. The straight grain diet was used only in 1939.

(c) Browse plus grains—diets (a) and (b) together.

Grains were hopper fed, each kind in a separate compartment. Browse was fed in the form of cut branches, rather than hopper fed. All kinds of group (1) were before the birds at all times (with the exception noted above), and were replaced with new material at least every ten days and sometimes more often; group (2) plants were fed somewhat less regularly. White birch browse was generally taken from open-grown trees or from the edges of thickets, as a preference for such browse has been noted by Schmidt (1936) and the Hamerstroms (unpub.). Brushy marsh willows were used instead of tree willows.

Hopkins and Rinzel cared for the birds throughout the experiment. Dr. T. T. Chaddock, Departmental Pathologist, Wisconsin Conservation Department, made pathological examinations of the birds which died during the experiment.

U.S. Weather Bureau station at Arlington, Wisconsin, about five miles southwest of the Game Farm.

The effects of the several diets on body weight are shown in Figures 1 and 2. Tables 1 and 2 express the same data on a percentage basis, using weights at the time of capture as the base. (Weight changes for each lot are calculated from the wild weights of its own members, rather than from an average of all birds together.)

Weight losses on browse alone were severe. Two males and one female starved to death, at 63.5 per cent, 58.3 per cent, and 70.1 per cent respectively, of their weights at the time of capture, in five, nine, and 11 days, respectively. More birds would certainly have died, had not grains been added to the browse diet in time.

The two instances of partial weight recovery on browse came during the spring break-up in 1939, at the time of a sharp and marked rise in temperature.[3] It may be that a diet of straight browse is adequate in mild weather, or it is possible that some supplementary food was found on the ground in the pens after the snow melted. In any case, we do not think that this weight recovery has any bearing upon the insufficiency of browse as a *winter* diet.

TABLE 2

EFFECT OF DIETS OF GRAIN ALONE AND BROWSE PLUS GRAINS, AS SHOWN BY BODY WEIGHT

Lot	Diet	No. birds	Average Weight per Bird				Average period of time
			At start	At finish	Max. loss below starting average	Max. gain above starting average	
Ba	Grains	7	92.4%	90.2%	2.2%	0.0%	19.9 days
C	Browse plus grains	7	88.2%	87.9%	0.3%	4.4%	35.3 days
E		8	88.8%	85.7%	3.1%	1.0%	43.0 days
Average		7.5	88.5%	86.7%	1.8%	2.6%	39.4 days
Ab	Grains added to browse diet	8	78.8%	85.4%	0.0%	6.6%	7.0 days
Db		7	81.5%	86.3%	0.0%	4.8%	15.0 days
Average		7.5	80.1%	85.9%	0.0%	5.8%	10.7 days

[3] Temperature for the five day period, March 18–23, during which the recovery occurred: mean 42.6°, maximum 75°, minimum 20°.

A comparison of Tables 1 and 2 shows very clearly that diets including grains are far superior to those without them. By converting the different time periods to uniform periods of two weeks each, the difference may be summarized thus: the birds on browse alone lost an average of 12.9 per cent per bird and three starved to death; addition of grains to the browse diet caused a gain in weight of

7.6 per cent; the birds on grains alone and browse plus grains lost only 1.5 per cent and 0.6 per cent, respectively, of their weights.

This contrast between diets with and without grains would probably have been even greater but for two things:

Infectious disease got into the control pen in 1939. Two males died of disease so early that they were not included in the calculation, and three males died of disease at the end of the experiment. No evidence of disease was found in the other pens. The rather minor weight fluctuations of Lot E (See figure 2) probably give a more accurate picture

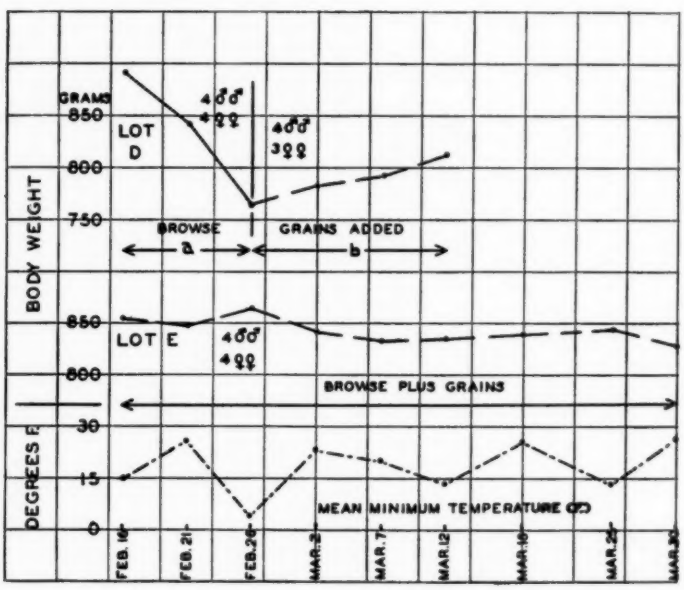

Figure 2. Effect of browse diet on Prairie Chickens, as shown by body weight: 1940.**

than the average of the two control lots. Secondly, the 1940 browse birds (Lot Db) show a poor recovery after the addition of grains, which we suspect is misleading. The females of this lot continued to lose weight during the first five day period of the supplemented diet (from 78.8 to 77.7 per cent), barely held their own during the next period (to 77.9 per cent), and made a slight gain during the last five days (to 80.3 per cent). Examination of sample droppings from this pen showed that very little grain was being eaten by some of the birds—perhaps by the females which did not respond to the change in diet. In contrast, the males of the same lot regained weight in a manner

** See footnote to Figure 1.

comparable to the behavior of the birds in Lot Ab, from 83.1 per cent, when grains were added, to 90.2 per cent at the end of the experiment. Part of the birds in Lot Ab regained slightly more weight after the addition of grains than they had lost on the browse alone (Figure 1).

Whether or not our interpretations of the few discrepancies in the data are correct does not alter the trend, but only—and slightly—the degree, of the main points: birds fed only browse lost weight rapidly, and three starved to death; the addition of grains to the browse diet was followed by a recovery of weight, in some cases to or above the weights at which they started the browse diet; birds on browse plus grains and grains alone practically maintained their weights.

Were these weight changes caused by anything other than differences in the diets? We think not.

The other factors most likely to influence the experiment are probably penning and weather. To pen so wild a bird as the Prairie Chicken introduces an unavoidable difficulty; unavoidable because pen-reared stock was not to be had. Although the birds became considerably tamer during the holding period, the effect of captivity ("penning factor") could not be entirely eliminated; witness the fact that no lot was at any time up to full wild weight. Judging by the behavior of the controls, penning depressed average weights by about 10 to 12 per cent. However, since the details of penning and handling were the same for all lots, it seems reasonable to suppose that the penning factor was the same for all lots, and that direct comparisons in weight behavior may be made among the different lots.

Of the various factors which together make up "weather," temperature is probably the only one which might have influenced weight behavior. The birds were protected against wind by a board wall 18 inches high around the bottom of the pens, and by small board shelters. Snow depth did not affect the food supply. Wild Prairie Chickens often roost under the snow, presumably to conserve body heat. Since the snow within the pens soon became packed down after each new fall, roosting under the snow was generally impossible; this, however, resolves itself into a question of temperature.

The range of winter temperatures included in the experimental periods apparently had not controlling effect on body weight. Between consecutive weighings, weights on browse went down as the temperature rose five times, went down as the temperature lowered four times; after the addition of grains weights went up as temperature went down twice, went up as temperature went up twice. The weight fluctuations of the controls, and of the birds on grains alone, did not at all parallel the weight changes of the experimental birds, either in time or in degree.

The paragraph above refers only to winter conditions. The weight increase at the end of the 1939 experiment has already been discussed.

There seems to be little room for doubt, then, that the weight changes in the experiment were due to diet—that browse alone is inadequate, and leads, at least in some cases, to death by starvation. We do not believe that the data are extensive enough to warrant more detailed analysis—rates of loss and recovery, and differential sex behavior, for example.

How closely the insufficiency of the experimental browse diet may be translated to conditions in the wild is probably a matter of opinion. It is true that the experimental birds were started on the different diets at sub-average weights, but wild birds may be reduced naturally to as low and lower average weights (Hamerstrom, unpubl.); what if they then have nothing but browse to eat? A comparison of weather conditions in the pens and in the wild does not weaken the argument, as the experimental birds had a slight advantage in this respect, since temperature alone was not important: they had protection against the wind, never found their food unavailable because of snow, and could always feed with a minimum of effort and exposure.

The question hinges upon whether or not captivity so upset the birds that they were unable to maintain weight on a diet which would be adequate for birds without that disadvantage. We cannot be certain.

Combine the experimental and observational approaches, however, and the answer seems to be quite plain: browse alone will not carry Prairie Chickens through the winter. Small numbers may be able to supplement a browse diet with an uncertain supply of weed seeds, but to have Prairie Chickens in quantity in the North Central States, winter grains are necessary.

Experimental Diets: Incidental Notes

A few incidental points seem worth reporting. Catkins of white and river birch and hazel, and the fruits of smooth sumac, were eaten much more than were buds of any kind. River birch catkins were eaten as readily as those of white birch, although neither Schmidt (1936) nor the Hamerstroms have seen river birch eaten in the wild. Rose hips were eaten freely in 1939, but not particularly so in 1940. The birds on browse alone ate much more browse than those on browse plus grains; the latter ate rather little browse. Birds on browse plus grains ate more grains than those fed grains only. Table 3 lists the grain consumption during the 1940 experiment.

Hopkins calculated the grain consumption in 1939 at about 1½ ounces per bird per day, with corn generally, buckwheat sometimes, as first choice, and wheat third. During both years grain consumption in the pens was about half of Hawkins' (1937) estimate for wild Prairie Chickens. Oats, barley, and rye were not eaten at all in 1939, and were discontinued after the second week.

The figures in Table 3 seem to give clear orders of preference among the different kinds of grain. Corn was always first choice, buckwheat was second eleven times out of twelve, the others shifted about somewhat in order of consumption. Hamerstrom is convinced that no such

TABLE 3

CONSUMPTION OF GRAINS, IN OUNCES: 1940

Lot	No. birds	No. days	Yel. corn	Buck-wheat	Wheat	Soy beans	Rye	Barley	Oats	Oz. grain per bird per day	Oz. grit per bird per day
Db	7	15	125	8	17					1.4	
E	8	45	427	68	16	10	10	5	1	1.5	0.04
Aver-age	7.5									1.5	

general preference exists in the wild. He has seen wild packs alternate between adjoining corn and buckwheat fields with a clear preference for buckwheat through most of a winter; others feeding on soybeans and refusing corn thrown on the ground for weeks at a time, then suddenly switching to corn for a few days; and still others alternating between corn and ragweed when both were equally available and in fields side by side. These shifts, with the possible exception of that from ragweed to grain, seemed not to be correlated with weather conditions; more significant, some packs preferred one grain at the very time that others would have nothing but another. While some packs were eating corn, others refused corn for buckwheat, and others refused corn for soybeans.

DISCUSSION

The foregoing data on food habits and food requirements stand up well enough as individual facts, but they seem to integrate poorly. For all that these things may be true, the Prairie Chicken is still a grouse, and may well be expected to feed as the others of the family do. Why such extravagant behavior?

It is extremely unlikely that the Prairie Chicken developed as a species along with the development of primitive cultivation. Aside from taxonomic grounds, the food habits of the other two subspecies point in the opposite direction. Gross (1928) and Forbush (1916: 386, 393) say that the Heath Hen ate grains, but Gross (1928: 550) says further " . . . in the winter months acorns, seeds, and certain berries found in abundance throughout the present range of the Heath Hen provide the birds with a livelihood. A comparatively small amount of snow falls on Martha's Vineyard, hence it is an exceptional winter when these birds are unable to secure sufficient food from native plants."

Lehmann (1939 and MS) has found that cultivated crops are not necessary to the Attwater Prairie Chicken (*T. c. attwateri*), and are but little taken. Further, according to Bogardus (1874: 73), Prairie Chickens in Illinois did not recognize corn as a food until several years after its introduction.

Perhaps on their original range and under original conditions Prairie Chickens subsisted on the typical grouse regimen of low concentrate foods. If so, there is no need to look further for an all-important native high-concentrate, such as acorns (Grange, 1939), "acorns or some legume" (Schmidt, 1936), or *Sylphium* (Hawkins, 1937). If so again, the importance of grains in the winter diet of chickens on their acquired northern range may be looked at in another light: the fact that they were adaptable enough to alter their type of feeding has made it possible for them to extend their range so far north of their original limits.

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F. N. HAMERSTROM, JR., UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN.

FRANK HOPKINS AND ANTON J. RINZEL, STATE EXPERIMENTAL GAME AND FUR FARM, POYNETTE, WISCONSIN.

GENERAL NOTES

A Swallow-tailed Kite in New Jersey.—On May 19, 1940, Gilbert Cant, Dave Fables, and I saw a Swallow-tailed Kite, *Elanoides forficatus,* at Edgar's Dock, on the north side of the Raritan River near Nixon, New Jersey. When the bird was first seen it was flying approximately northeast toward us. Several times it soared in circles of about an eighth of a mile radius, once passing within 150 feet of us. We could then distinguish the white underparts and the bluish-black colorings of its wings and tail.

According to Witmer Stone ("Bird Studies at Old Cape May," p. 269), there are six records of this species for New Jersey, the last record having been made in southern Cumberland County on June 4, 1893.—WILLIAM F. RAPP, JR., *130 Washington Avenue, Chatham, New Jersey.*

Bald Eagle Nesting in Kentucky.—For many years no occupied nest of the Bald Eagle (*Haliaeetus leucocephalus*) has been known in Kentucky. One of the few published references to breeding eagles in the state is found in an article on the birds of Fulton County by Leon O. Pindar (*Wilson Bulletin,* 37, 1925:85.) in which he mentions several pairs that were nesting during the 1890's on Island No. 8 in the Mississippi River near Hickman, Kentucky. Consequently we heard with keen enthusiasm rumors of Bald Eagles nesting in Ballard County, Kentucky, near Wickliff. We are indebted to Captain R. C. Soaper, federal warden stationed at Henderson, for reports as to the actual location of the nest.

On June 28, 1941, the junior author visited the area of Swan Pond, four miles west of Wickliff in Ballard County, and directly across the Mississippi River from Cairo, Illinois. After considerable search in the heavy cypress growth at the west end of the 500-acre pond he was able to locate the nest, which at that late date was unoccupied. However two immature Bald Eagles and an adult bird were seen in the immediate vicinity, and local residents were unanimous in asserting that young had been reared in the last two seasons. Unfortunately the situation of the nest, high in a very large cypress, and well screened from below, was unsuited to photography.—BURT L. MONROE and ROBERT M. MENGEL, *Louisville, Kentucky.*

The Dance of the Sandhill Crane.—On May 2, 1939, at Portage Lake, Jackson County, Michigan, the following observations were made by Leonard Allison and the writer. The observations were made while lying in the sedge flats approximately 300 feet from a couple of Sandhill Cranes (*Grus canadensis tabida*).

When first seen the two cranes were quietly feeding along the moist banks of a shallow pond. Presently they ceased their feeding and retired a few feet to drier ground. One of the birds picked up a stick and dropped it quickly. The other bird became quite erect and slowly walked across the marsh with its neck very straight, but with the entire rigid neck and head swinging forward and backward. It gave the appearance of a crane moving forward with its head fastened by some invisible force which suddenly relaxed and let the stiff neck swing forward from its junction with the body, only to be temporarily held back again.

In the next stage of the dance the birds began bowing to each other and slowly flapped their wings. This presently developed into a drunken weaving motion with the birds reeling from side to side and also rocking to and fro. Finally they began jumping backwards, leaping into the air 2 or 3 feet, with their wings flapping and their legs dangling forward. The frenzy of this stage gradually subsided until the birds began bowing again, and both birds picked up sticks only to let them fall to the ground. The entire dance took about 3 to 4

minutes and was repeated again after 4 or 5 minutes of less active bowing or walking, and took place in a rather small area of perhaps 25 feet in diameter. After five dances, all of which were of the type described, the birds resumed feeding.—JOHN L. GEORGE, *Department of Zoology, University of Michigan, Ann Arbor, Michigan.*

The Starling in Jackson, Wyoming.—On the morning of April 5, 1941, at my home at Jackson, Wyoming, I saw a bird fly off in a characteristic fluttering manner that instantly marked it as a Starling (*Sturnus vulgaris*). It was snowing lightly at the time. The bird alighted for a moment on a neighbor's lawn, then went into a row of willows. With field glasses I pursued it for a time but finally lost it among a lot of English Sparrows in the thick brush. A Sharp-shinned Hawk had dashed through the neighborhood and all the birds about me had taken to cover. Upon my return to my own yard, there was the Starling, and this time I had an opportunity to observe it closely, to note the yellow beak and characteristic plumage before it flew away.

McCreary ("Wyoming Bird Life") records the Starling in southern Wyoming in 1937 and 1938. This is apparently the first occurrence in Jackson Hole.—OLAUS J. MURIE, *Fish and Wildlife Service, Jackson, Wyoming.*

The Strange Death of a Young Grackle.—In a small swamp just south of Ithaca, New York, on the morning of May 18, 1941, we found a dead fledgling Bronzed Grackle (*Quiscalus quiscula aeneus*) dangling by a string from a willow twig. Instead of the usual string mortality caused by entanglement of the head, wings, or feet, this bird died through *swallowing* the string. Death occurred after a loop of the string hanging from the mouth caught around a leaf. Death must have occurred, at the very earliest, during the prior evening, since the bird was quite fresh.

Dissection of the digestive tract revealed the following: One corner of the mouth was grossly irritated, probably as a result of rubbing of the string during the bird's struggles. A double length of string passed through the esophagus terminating in a tightly packed wad of string in the proventriculus and ventriculus, thus making an exit through the pyloris impossible. The wad of originally white cotton string was sticky and stained yellow from the action of gastric juices. The total length of the string, including some three or four inches which protruded from the mouth, was eleven feet, ten inches, although the bird had probably swallowed a much shorter tangled mass rather than the entire length of string inch by inch. The condition of the bird was otherwise apparently normal.

How this young grackle, perhaps two weeks old, and still dependent upon the parents for food, happened to get this unusual item in its digestive tract is purely conjectural.—KARL W. KENYON and LEONARD J. UTTAL, *Cornell University, Ithaca, New York.*

Unusual Behavior of a Banded Cardinal.—On April 24, 1941, three small boys in my neighborhood brought me, alive, an adult male Cardinal (*Richmondena cardinalis*), which I had previously banded. They stated that they had found this bird flopping about the grass, his beak tightly clamped about his band. When handed to me he was still grasping his band. His tail feathers were gone and he was quite thin but otherwise appeared in good health. The history and behavior of this bird is so unusual that I would like to relate it chronologically.

On December 27, 1939, this bird was banded No. 39–223571. At that time he was a fully matured male and there was nothing unusual about his behavior,

except that he was a squealer and quite vicious, but this is not uncommon among Cardinals.

On New Year's Day, 1940, he repeated, and he had so worked on his band that the numbers were badly worn and the band was mashed tightly around the tarsus. I removed the band and substituted No. 39–266001.

He repeated again on March 10, 1940, and although his band was in good order, his behavior was such that I made a special note of it on my daily banding sheet. Upon removing him from the house trap, he grasped his band in his beak, and I used considerable effort in forcing him to release it. In the gathering cage he grasped the wires, and I was again put to considerable effort in getting him loose. After ascertaining his band number, I released him by placing him on the ground. Instead of flying away, he reached down and grasped his band again. My notation reads, "Even when released this bird continued to bite his band, and would not turn loose until rolled over several times and shaken. Squealing all the time."

On April 24, 1941, I found his band so worn as to be barely discernible and again it was mashed tightly against the tarsus. I again removed the band (after considerable difficulty, for he was exceedingly vicious) and fitted a new band. I placed him on a low branch of an apple tree. He seemed too weak to fly and fluttered to the ground. After taking a few steps, he saw the band and immediately clamped down on it and rolled over. He made no effort to move when I picked him up. Twice again I gave him a fresh start, but each time he no more than perceived the band than all thoughts of his own safety were forgotten in his hatred of it. It was thus obvious that if the band was not removed he would not survive the local predators. There was nothing to do but release him, unbanded. This I did, and although he could not fly, he hopped away with vigor and lost himself in the underbrush.—JAMES B. YOUNG, *2516 Talbott Avenue, Louisville, Kentucky.*

WILSON ORNITHOLOGICAL CLUB LIBRARY

The following gifts have been received recently:

T. H. Bissonnette—22 reprints
Frederick N. Hamerstrom—2 books, one pamphlet
John B. Lewis—10 periodicals
Margaret M. Nice—7 reprints
James Savage—2 periodicals
O. A. Stevens—1 bulletin
George J. Wallace—1 reprint
J. M. Winterbottom—23 reprints

EDITORIAL

The Wilson Club's Illustrations Committee is interested in bettering the illustrations of the *Bulletin* and in finding funds for reproducing there more pictures. The Committee has in mind amassing a sizeable sum of money which will pay for more half-tones and, eventually, one or more color plates in each volume. Donations will be gratefully received, of course, but the Committee's present plan for increasing the size of this fund is to sell, at the coming meeting, certain originals that have already been reproduced. We hope that other artists will eventually contribute paintings or drawings for this purpose, but at the next meeting at least ten small-sized Sutton originals will be placed on display to be sold at a moderate figure for the benefit of the fund. Pictures to be placed on sale include small sized water-colors of the following species: Ruffed Grouse, Red-wing, Great Horned Owl, Crested Flycatcher, Bluebird, Bald Eagle, and Prairie Chicken.

Members are reminded that two important proposals (see page 59 of the March *Bulletin*) for increasing the Club's income from dues were placed on the table last year for final decision at the 1941 Annual Meeting. Economic changes since last November make it even more imperative that some action be taken. No other comparable bird journal is maintained on such low minimum dues. We have managed to balance the books for the last year or two only by virtue of the generous donations of a few individuals. Obviously we cannot expect them to carry permanently the burden which should be shared by all the members.

We had a number of requests in response to the offer we made last year to supply reprints of our lists of current bird papers for cutting and pasting on bibliography cards and this has now become a regular *Wilson Bulletin* service. Since the annual sets cost only a few cents, some members get two sets and maintain one set of author cards in addition to the set filed by subjects. Experience has shown that, while subject entries must for flexibility be posted on separate cards, as many as eight or ten titles by one author can be posted on one library card, thus saving much space in the author files.

Others interested in obtaining these reprints should apply to the Editor.

The Annual Meeting of the Wilson Ornithological Club for 1941 will be held on the University of Illinois campus, November 21 to 23. Dr. Kendeigh, chairman of the Local Committee on Arrangements, reports that headquarters will be in the attractive new Illini Union Building. Members and guests will find comfortable lounging rooms there for conversations and for conferences. Luncheons and the annual banquet will be in this building, which is centrally located in respect to the meeting place and the hotels. Living quarters should be arranged for in advance at any of the main hotels: Tilden-Hall or Inman in Champaign and Urbana-Lincoln in Urbana. Rates are reasonable and, in addition, tourist rooms on the main highways are available. City busses provide quick and inexpensive transportation from any part of the twin cities to the Headquarters and to the place of meeting. Most of the sessions will be held in Gregory Hall.

Members should be considering what papers they will present, for the titles will be requested in the Secretary's letter that all members will soon receive. As a special feature of the program plans are being made to portray ecological and experimental aspects of bird study. Dr. V. E. Shelford has consented to serve as chairman of a symposium dealing with some phase of ecology in relation to bird studies. Dr. Shelford has long been a leader in this country in animal ecology and his discussion will be of special value to bird students who wish to know more

about how to use ecological principles in their own field work with birds. Members will be given an opportunity to inspect the facilities and equipment for this kind of work at the Vivarium Building and to observe researches under way. The new Natural Resources building, where the Illinois State Natural History Survey is conducting many studies dealing with conservation and wildlife management, will also be open for inspection.

For Sunday there is planned a trip to the Chautauqua Wildlife Refuge near Havana, where a large number of waterfowl may be expected at that season of the year. The trip will include a stop at the new Natural History Survey Laboratory located on the Refuge, with an inspection of the work with water birds and other animals that is being conducted there.

We expect a large attendance for our Annual Meeting at this important and conveniently-located ornithological center which the Club has never before visited.

June 3, 1941.

To the Editor of the Wilson Bulletin:

For the benefit of your readers, I am submitting this report of progress on my series of Bulletins on the life histories of North American birds.

The fourteenth volume, on flycatchers, larks and swallows, will go to the printer very soon, though it will not be published before some time next spring, as the Government Printing Office is congested.

My work on the fifteenth volume, containing the Corvidae and the Paridae, is now all written and will go to the publishers this fall.

I am now starting work on the sixteenth volume, to contain all the birds on the 1931 Check-List from the Sittidae to the Mimidae inclusive. I should be glad to receive, as soon as possible, any notes, data or photographs relating to any of the birds in these six families.

The sooner these are sent to me, the more likely they are to be included in the work, and the more conveniently I can handle them.

I wish to thank all former contributors to this co-operative work for the valuable material sent to me in the past, and to solicit their help in the future. All material is welcome, though I can use only the most important part of it.

Sincerely yours,

A. C. Bent

140 High Street,
Taunton, Mass.

OBITUARY

Myron H. Swenk, formerly president of the Wilson Club and associate editor of the *Bulletin*, died at his home in Lincoln, Nebraska on July 17 at the age of fifty-seven. Professor Swenk, long chairman of the entomology department of the University of Nebraska, was also the recognized leader in ornithology in his state. He was the founder and editor of the *Nebraska Bird Review* and in addition published there and elsewhere a series of scholarly contributions of his own to the ornithology of the West.

WILDLIFE CONSERVATION

Mining on Public Lands

The Wilderness Society calls attention to a serious potential danger to public lands (see *Wilderness News*, No. 14, March 12, 1941). Senate Resolution 53, introduced by Senator O'Mahoney, calls for an "investigation with respect to the development of the mineral resources (including oil and gas) of the public lands of the United States, and of the existing laws which relate to such development, with a view toward (1) providing for more effective development and utilization of such resources for the purpose of national defense, (2) fostering free competitive enterprise and the investment of private capital in the development of the mineral industry and the production of essential and useful minerals, and (3) conserving such mineral resources to the fullest extent which is consistent with their proper development and utilization."

In the same article, Senator O'Mahoney is quoted as having said, in part, "Anyway, we could not forever expect the resources of the National Parks to be locked up when some of the minerals might be vitally needed for national defense."

Conceivably, some of these minerals might be needed under a defense emergency, but it is disquieting to learn that "competitive enterprise" has been considered on practically equal footing, and without specific exclusion of national parks and monuments, or of wilderness areas. The situation is the more serious as our present mining law—now almost sixty years old without amendment—is wholly inadequate to protect the public interest, should more mining be allowed for any reason on public lands.—F.N.H.

Conservation and National Defense

Albert M. Day, of the Fish and Wildlife Service, was recently detailed to act as liaison officer between national defense and conservation programs. He is to ensure that the operations of the War and Navy Departments, and of commercial firms under the Office of Production Management, do not damage wildlife.

First fruits of this provision have already appeared. According to *Wildlife News* (July, 1941, 1, 5), several bombing and gunnery ranges have been shifted or adjusted to spare areas especially valuable to moose, caribou, furbearers, and waterfowl. The plan also calls for the prevention of stream pollution by sewage from encampments and by government defense-industry wastes: two mobile field laboratory crews are being organized to make sure that specifications are followed.—F.N.H.

Yellowstone Coyotes

The Murie brothers score again—this time Adolph Murie, with his study on the "Ecology of the Coyote in the Yellowstone" (*Fauna of the National Parks, Bull. No.* 4, 1940), The coyote has been accused of many things in the Park, among them destruction of Trumpeter Swans. Murie says, "The data available at the present time indicate that the coyote does not represent an important mortality factor for the Trumpeter Swan." The same may be said for other animals except rodents.—Leonard William Wing.

Waterfowl

"Within recent years there has been agitation for an increase of the hunting season on the basis of the Bureau of Biological Survey report of an increase of five to ten per cent among the waterfowl. True, there has been an increase; but at the rate of a five per cent annual increase, it would require 14 years to restore the waterfowl population to 50,000,000 birds, one-half of the 1930 population which was considered a crisis population at that time." (from G. N. Rysgaard, "A short history of waterfowl," *Conservation Volunteer*, 2, No. 9, June, 1941:75–9.)

Parenthetically, it is encouraging to find a statement of this kind in the official publication of a state (Minnesota) Conservation Department.—F.N.H.

Humane Traps

The American Humane Association, after its thirteenth annual trap contest (in 1940), announced the development of chain leg-hold traps which "will do anything the steel trap will do"; i.e., equals the steel trap in the four qualities of humaneness, efficiency, practicality, and reasonableness of cost. The Association considers leg-hold traps markedly more humane, and claims that they "go the steel trap one better by obtaining [for the trapper] an undamaged pelt." (*The National Humane Review,* 28, No. 7, July, 1940:3.)

Following their fourteenth annual contest, in 1941, the Association now says, "Humane traps of all types have now come to light which [compared with steel traps] are just as cheap to manufacture, just as light to transport, easier to set and more efficient." (*Ibid.,* 29, No. 7, July, 1941:5).—F.N.H.

WILDLIFE CONSERVATION COMMITTEE

Frederick N. Hamerstrom, Jr., Chairman

ORNITHOLOGICAL NEWS

The officers charged with the arrangements for the Tenth International Ornithological Congress scheduled to have been held in the United States in 1942 announce that the proposed meeting has been indefinitely postponed.

Material for a biography of Louis Agassiz Fuertes, naturalist and bird artist, is being collected by his daughter, Mrs. Mary Fuertes Boynton, R.D. 3, Trumansburg, New York. She is eager to have letters written by Louis Fuertes, as well as anecdotes and personal recollections. Letters sent to her will be copied and returned to the owners promptly.

Burt L. Monroe has been appointed State Ornithologist of Kentucky.

Harry C. Oberholser retired on June 30 after forty-six years of distinguished service in the "U.S. Biological Survey." Since his retirement from the government service he has been appointed curator of birds at the Cleveland Museum of Natural History. Dr. Oberholser is one of the Wilson Club's members of longest standing. He joined in 1894, the year the *Bulletin* began publication.

The Annual Convention of the National Audubon Society will be held at Audubon House in New York City from Friday evening, October 17 through October 21. There will be field trips to Cape May, New Jersey, and Montauk Point, Long Island on October 18 and 19. The meeting will be featured by the showing of some of the finest wildlife motion pictures in color. The public is cordially welcome.

The Fifty-ninth Stated Meeting of the American Ornithologists' Union was held in Denver September 1. to 6. The former officers were reelected. The Wilson Ornithological Club was represented at the sessions of the Council by George M. Sutton. The 1942 meeting will be held in Philadelphia.

ORNITHOLOGICAL LITERATURE

A Field Guide to Western Birds. By Roger Tory Peterson. Houghton Mifflin Company, Boston. 1941: 4½ x 7¼ in., xviii + 240 pp., 6 col. pls., 40 black and white pls., 40 text figs., map. $2.75.

The Editor of this journal may have erred in requesting the undersigned to review the present work, for the latter professes partiality for Mr. Peterson's unique style of field bird guide. The novelties introduced in this author's "A Field Guide to the Birds" (1934) and elaborated upon in the revised edition of 1939, appear to have reached culmination in the present work. At least, it seems to this reviewer that there is little room left for improvement. We doubt whether any other person in this country combines Mr. Peterson's qualities for conciseness of expression, both in illustration and in print, of the essential identification points of birds, features which are expressed in every page of this book.

With these words of well merited praise, we turn to a brief description of the book. Although it contains 260 pages of material plus 46 unnumbered pages of plates, the book is not beyond "pocket" size; but it would seem a pity to so abuse such a valuable little volume. The 201 pages of main text are interspersed with the 40 excellent pen and ink figures, many of which depict details of identification points; while each plate usually portrays from five or six to twenty or more species in Mr. Peterson's characteristic, diagrammatic style. The book's scope is conveniently indicated by a map and includes the eleven western states, western Texas including the Rio Grande valley, and the western part of the Great Plains area. Here it is noted that observers in the eastern margin of the area will also require the eastern companion volume to cover adequately their regions.

The plan of the book closely follows that of its revised eastern predecessor, except as regards the treatment of subspecies. Thus, a brief preface and directions as to how to use the book comprise the 18 introductory pages. Here the novel treatment accorded subspecies is but briefly mentioned, while this important matter is more fully explained in the form of an addendum, where a list of the subspecies and their ranges is also provided. It would seem more logical to have included the remarks about subspecies in the preface and the reviewer urges readers to peruse this section before using the book. That this was not done was probably due to the author's commendable desire to de-emphasize the subspecies in field identification work. Mr. Peterson has handled this difficult subject in an admirable and courageous way. His efforts in this direction should do much to lighten criticism of similar changes contemplated for the next edition of the A.O.U. Check-list.

Briefly, in most cases only the species or the single subspecies, if but one form occurs within the scope of the book, is named and figured. Where several races of a species occur, the common and scientific names of all known from the region are listed at the end of the species' accounts. The range is here provided for the entire species only and is restricted to the scope of the book. Subspecies' ranges are, as stated, listed in the addendum. It would seem to have saved some space to have given the subspecific ranges in the main text, but such procedure might have added importance to subspecies which the author desired to avoid. There are a few exceptions to this rule, cases in which it is possible to identify subspecies in the field, like the races of the Canada Goose and White-crowned Sparrow, in which instances the field identification marks and the ranges of the subspecific forms are provided in the main text, following the species accounts.

There are included 534 forms which are treated as species. This includes practically all of the wild birds of the area, even "casuals" and seven introduced species. Under these main forms, not more than about ten subspecies in all are described as being identifiable in the field. In all other cases the subspecies are referred to as having "no apparent field differences," their field identification being

thought to be either very difficult or impossible. This is certainly a step in the right direction with which most ornithologists will heartily agree.

Each main form is named, usually with the A. O. U. Check-list's vernacular and scientific names. If there are subspecies in the area, the note "Subsp." follows. Then comes a reference to illustrations and in many instances, especially of ducks, hawks, shorebirds, and gulls, there are two or three figures of a species. Next the length of the bird is given in inches at the beginning of the word description which covers both sexes if different and sometimes immature plumages as well, always concisely stressing field characteristics. In many instances there follows a section on voice, but this is so frequently omitted that one wonders how little may be published elsewhere in this connection. In the cases of the similar appearing species of the *Empidonax* flycatchers and of subspecies of the White-crowned Sparrow, where the birds' songs may differ more than their plumages, helpful diagrammatic song analyses are provided in the text. Finally, the form's range within the scope of the work is provided, and following this, the subspecies if any, are listed.

The success of Mr. Peterson's books, we think, lies principally in his excellent diagrammatic drawings and in their number. In this respect the present volume is especially rich. Of the 534 species treated, 464 (87 per cent) are figured. A number of them are illustrated four or more times to show the sexes, ages, and various postures. Thus this is truly an illustrated manual and as such it will no doubt be especially useful to beginners in bird study. The author has expressed excellent judgment in his choice of the 70 forms which are not figured. Thus, such well known birds as the Crow and Robin are not illustrated. Other kinds so eliminated include mostly rare or casual occurrences that are either strikingly individual, as the Whooping Crane and Spoonbill, or so similar in appearance as to render portrayal of the differences difficult or impossible. Some shearwaters and the *Empidonax* flycatchers, of which only the Western is illustrated, are examples of the latter category.

The author states in the preface that the Field Guide is not intended to replace Hoffmann's *Birds of the Pacific States* in the area (Washington, Oregon, and California) which both cover, but rather the latter is to be used as a companion piece to the former. In the other western states, the present guide should fill a much needed want. Mr. Peterson acknowledges Hoffmann's more thorough treatment of bird voices and habitats with the statement that such detailed consideration was impossible in a book the size of the present one.

The entire work is so well done and free from typographical and other errors that it would be uncharitable indeed to mention the remarkably few lapses that have come to the reviewer's attention. Perhaps the frequent omissions of a species' voice or notes, already mentioned, is a criticizable point; but here many of us can blame ourselves for not publishing what we know of this important subject, rather than the author. No one person can be expected to know the notes of every bird of a region, and for North America, Mr. Peterson probably knows as many as does any other person.

The excellence, usefulness, and modest cost of this book should be incentive for everyone interested in birds to own a copy. Certainly, this should apply to all bird students in the West, while to those in the East who know their birds well, the western guide will probably be more interesting than their local one.—James Moffitt.

BIRD ISLANDS DOWN EAST. By Helen Gere Cruickshank. With photographs by Allan D. Cruickshank. The Macmillan Company, New York, 1941: 6 x 8½ in., xii + 123 pp., 50 photos.

With exceptional charm Mrs. Cruickshank writes her first book—the adventures she has shared with her ornithologist husband among the sea bird colonies of

Maine's isolated, coastal islands. Thus, we read of many experiences encountered while studying and photographing the Puffins and Leach's Petrels of Machias Seal Island, the Double-crested Cormorants of Old Man Island, the Laughing Gulls and Black Guillemots of Little Green Island, the Arctic Terns of Matinicus Rock, and the Great Blue Herons of Otter Island. We read, too, of banding Herring Gulls on Western Egg Rock, of late summer trips to Monhegan Island to view migrating birds, of Hog Island with its perennially used Osprey nest and the Audubon Nature Camp with which the Cruickshanks are associated.

The book is most attractive, its jacket appropriately embellished with a photograph of a Puffin, an avian personality which Mrs. Cruickshank believes is the one northern colonial nesting bird that bird watchers are most anxious to observe. The text is relatively brief, simply worded, and offers smooth enjoyable reading. Not a compendium of ornithological lore, the book is nevertheless sound ornithologically, with keen observations and vivid descriptions coupled with touches of good humor and warm feeling for Maine's seaboard environment. The many photographs with which the book is generously illustrated are superb.—O. S. Pettingill, Jr.

THE AUDUBON GUIDE TO ATTRACTING BIRDS. Edited by John H. Baker. Doubleday, Doran and Company, Garden City, New York, 1941: 5½ x 8 in., xviii + 268 pp., frontispiece in color, 8 pls., 11 pp. of line drawings. $2.50.

This helpful volume is written by four members of the National Audubon Society staff, Roger Peterson, Richard Pough, Dorothy Treat, and Mr. Baker. The book is designed to be a guide to practical methods any bird lover can use in attracting birds around the home or sanctuary, and it accomplishes its purpose very well. The emphasis is upon song birds, but predators, and waterfowl, and other game species are also included. The book is broader by far than its title implies, for in addition it treats of several other topics of interest to the bird student.

In his seven opening chapters, which constitute the bulk of the book, Roger Peterson easily maintains his solid reputation. His contributions are readable and entertaining, as well as useful. Many a bird student, experienced as well as novice, will find helpful suggestions in his sections on methods of study, choice of a binocular and camera, and technique of bird photography.

In attracting birds the why of each procedure as well as the how are considered. Territorial behavior of the birds, ecological succession, the effect of insecticides upon the bird population, a sane attitude toward predators, and even a chapter on the legal aspects of trespassing, liquidating your neighbor's cat, and of other minor temptations which occasionally face the bird lover—all find their place. These and many other topics must naturally be treated very briefly, but the total effect is surely to broaden the outlook of the average student of birds.

All of the familiar, and many new and novel methods of attracting birds are described. Bird houses, bird baths, bird feeders, and the choice and arrangement of trees, shrubs, and other plants for cover and food are all treated effectively.

In such an all-inclusive work it is small wonder that there are points which a reviewer would question. Are birds really so essential that without them, as Mr. Baker says, "trees . . . would wither; crops would not thrive; lawns would deteriorate; ponds and streams would become polluted; soils would erode"? Many an entomologist, probably as capable to judge as we ornithologists, would doubt it. The old food patch mixture (p. 54) of 16 varieties of seed quoted from the Michigan Department of Conservation has in recent years been greatly improved by simplification. Wood Duck boxes (p. 115) are usually unsuccessful without a generous layer of sawdust or rotting wood in the bottom. The list of plants (pp. 226–247) would have been more useful, we believe, if it had included fewer species,

with more information about each. Red cedar, barberry, and buckthorn are all recommended with no caution against the fungus diseases for which they serve as alternate host. Beach plum is described as a "good" bird food, although actual records of its use by birds are few and far between. And why, in a book on attracting birds, does the frontispiece and only colored plate depict the Great Blue Heron, which it is practically impossible to attract?

These are all minor details, however. This book, the leader in its field, will be a profitable addition to the library of every bird lover.—Gustav Swanson.

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